LIFE, FUNCTION, HEALTH.

LIFE, FUNCTION, HEALTH.

Studies for Young Men.

BY

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ADVERTISEMENT.

The Lectures contained in this volume were delivered before the Young Men's Christian Association in Aldersgate Street, and afterwards published in three separate volumes under the titles of "Life Studies," "The Body and its Functions," and "Health Studies." Of the last named, the Rev. C. H. Spurgeon, in reviewing the volume in his *Sword and Trowel*, says:

> "If we had chosen the title for these lectures it would have been 'Fascinating Physiology,' for we have never read such able medical advice put in such charming and lucid language. The technicalities which repel so many from the study of physiology are all but abandoned, and Dr. Paterson talks away with great simplicity—with the simplicity of masterly knowledge. Let every boy growing up into manhood have a copy; ay, and every girl growing into womanhood, too."

It is believed that in the present day, when the dissemination of sound knowledge about life, the body, and health, is felt to be of such importance, that these popular lectures in their complete form will prove acceptable to a large class of readers.

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STUDIES IN LIFE.

I.

NATURE, AND THE STUDY OF NATURE.

THE subjects to which I intend inviting your attention during this course have an immediate value and interest. Apart from their relations, they deserve close and careful study. But, as you are aware, at the present time there are many questions raised concerning the relations between these teachings of science and the contents of the Bible.

It is not my purpose to defend the Scripture, or to prove that it has given to us, in regard to such matters, a full and definite revelation of God's thoughts; but *it is* my design to show, and I hope to be able to accomplish that design, that we have as yet no real knowledge of nature that warrants suspicion or rejection of the claims advanced by the Bible.

We have been accustomed to hear that there are two books, each of which occupies a definite place: the Book of Nature, containing God's works; and the Book of Scripture, containing God's Word. And in a former generation Bishop Butler very carefully showed that there is an analogy between religion, natural and

revealed, and the constitution and course of nature. He discussed that analogy fully and successfully, and thus ended the controversy existing in his time. However, we have been recently told that this argument fails to meet our present exigency. In a former age it was contended that the Bible was written by inspiration of God; that holy men of God spake as they were moved by the Holy Ghost; and that all Scripture being "given by inspiration, is profitable for doctrine, for reproof, for correction, for instruction in righteousness: that the man of God may be perfect, throughly furnished unto all good works" (2 Tim. iii. 16, 17). Now it is contended that the Book of Nature is not the work of God; that the things that are made do not show His Eternal Power and Godhead. The controversy has been somewhat changed, and very considerable doubts are expressed with regard to the meaning of the facts with which we are familiar in the study of Nature. I venture to say, however, that our most eminent men of science, both in the past and present generations, have had no doubt in their minds as to the Divine origin of the subjects which they have studied. It was said, not long ago, by one eminent writer, that the men best known for their scientific attainments were not ready to acknowledge the existence of design in nature; but this statement was answered by an eminent professor[1] in one of our universities, who gave

[1] Professor Tait, *International Review.*

the names of the most eminent men who have recently left us, and of the most eminent men still with us, in contradiction of the writer's assertion. There are some —and we need not fear to acknowledge it—who have attained eminence in certain scientific studies, who really do insinuate, or rather express boldly, their belief that there is no evidence from nature in support of the existence of God. But I contend that an impartial investigation shows that we have, so far as testimony goes, quite as full support for the doctrine of the Divine existence, at the present hour, as we have had at any time in the past. Apart altogether from that, however, I venture to say that there is no other choice than between these two theories—the theory of Divine origination, and the theory of chance—the theory that all things are the outcome of an intelligent mind and personal will; and the theory that all things that exist around us have happened just because they have happened, without any cause or necessity of any sort being imposed upon them. Those who adopt this second theory must logically give up all belief with regard to causal existence of every sort. Their hypothesis strikes vitally at the root of human knowledge, and, carried out consistently, can only end in universal doubt, or pyrrhonism.

I do not intend entering upon the argument from nature in proof of the existence of God, further

than to say this—that we must, at all events, admit that there is a sufficient cause for all things that begin to be. I do not mean to affirm that every existence must be caused, for I hold that the existence of God is uncaused; but all *events*, or *results*, must have a cause. And the Presiding Power must have had intelligence and unity of will. Put it in this way—take the reverse supposition first. All the atoms that existed, and of which the world is composed, must have somehow conspired together to arrange themselves in all the varieties of form in which they have appeared, and to produce all the variety of substances that exist, or they must have been under the direction and control of some Intelligence outside themselves. Either we must have an indefinite number of *intelligent* and *designing* atoms, or one Supreme Intelligence superintending the arrangement of them all. And to my mind the unity that exists through the universe—the very term "universe" implies unity—is plain enough indication that there is a central will, a dominant power, working all things according to its own counsel, and knowing the end from the beginning.

I do not proceed further with this argument. It lies outside the range of the present discussion. I merely add that I study nature as the work of God. I accept with all my heart what Augustine said long ago: *Voluntas Dei rerum natura est*—"The will of God is the nature of things." I think

that is profoundly philosophical, and the more we examine it, the more do we find it thoroughly and exactly true. People talk of nature as if it were something apart from God, and they actually deify that which has no existence in order that they may avoid the necessity of admitting the superintendence and working of a Supreme Deity. Think of the many things that it is said nature does. Think of the many operations which nature is supposed to carry on. Think of the variety of functions and the variety of intelligent purpose that must be exercised by nature in order that this world may exist as it does, and that the various results we see produced may occur, each in their due order. To my mind it is far more rational, apart from this Book of Scripture altogether, more in accordance with the dictate of our unbiassed reason and our clearest thought, that there should be one superintending Divinity, possessing all the intelligence that is manifested in His works, possessed of all the power displayed by these works, governing all things according to His own purpose, and for the final issue of His own design.

With regard to the two books of which I have spoken, the question has been raised: Is it possible to reconcile the various statements that *we read* in the Bible with the various facts that *we find*, on examination, in the universe? I take exception to the question raised in that particular form. It is said that Science

and Scripture are at variance. If you put it that Science and the interpretation of Scripture may be at variance, I have no objection to that statement. Scripture is one thing, and nature is another thing. But the interpretation of Scripture is quite a different thing from Scripture itself. And the interpretation of nature is quite a different thing from nature itself. Nature is the one Book of God that I recognise as manifesting His working, and the Bible the other Book that I recognise as revealing to me His will. And these, I am thoroughly convinced, are one in all their mutual statements, and in all relative matters wherewith they respectively deal. But as to man's interpretation which we call theology, or as to man's interpretation which we call science, I am not prepared to say that I believe the one or the other is infallible. I do not acknowledge an infallible Pope, either at Rome or in any of the universities. Neither do I acknowledge that the theologian is entitled to compel my belief with regard to his reading of Scripture, or the scientist my faith with regard to his reading of nature. When you have lived as long as I have done—and that is not very long—and watched the various changes that take place in scientific theories, over say a period of thirty years, you will arrive at the conclusion that it is neither safe nor wise to attach one's faith very strongly to any particular theory that may be in the ascendant at any particular

time. I remember when it was supposed that all the varieties of men sprang from different pairs, and that there were at least five pairs, if not fifty, giving origin to the various classes into which we may easily divide the human race. Now we are told that, not only may all men have sprung from one pair, but that all varieties of animals—beasts, birds, and fishes—have evolved themselves from a little speck of jelly that floated in some sea ages ago! Of course I know that the element of time is introduced to explain this. But there was no talk of time in the past days, when it was assumed that there must have been as many pairs as there were distinct varieties of the human race. People talk about the warfare between the Bible and science. I am inclined to talk of the warfare between the science of to-day and the science of yesterday. I do not sympathise with theologians who accept this particular form of science or the other, and contend for it at all hazards, making out its agreement with the Bible, or asserting that otherwise the Bible is in danger. I do not at all sympathise with them when they find themselves worsted or thrown into the background. Many did that long ago, and what a hindrance to the truth they were. For instance, there was the theory that this earth was the centre of the universe, and that the sun and planets revolved around it. When the Copernican theory was established, and it was proved that the sun was the centre, and that the earth and

planets revolved around it, men shouted out in great dismay that the Bible was contradicted, and that the Christian faith was at stake. And the believers in the old science were ready to persecute the believers in the new. It was not theology against science; but science in alliance with theology against novel discoveries. We do not tie down the Bible to any interpretation given by scientific men to the facts of nature. We accept it as that which it professes to be —God's revelation of His will in regard to certain matters of faith and duty. And in accepting that revelation we are willing to interpret its language according to the laws of human language at all times and in all circumstances.

Let me give you an illustration. There are many things said in the Bible that may appear at first sight contradicted by the plainest facts of science. Take the miracle, as we generally talk of it, wrought when Joshua is said to have caused the sun and moon to stand still. I am aware, in using this illustration, that two theories have been adduced which seem to remove the necessity of our arguing in the direction in which I am at present disposed to argue. One writer[1] says a more exact interpretation of the Hebrew would allow us to believe that, instead of Joshua wanting brightness or sunshine, he wanted darkness; and what he asked was that the sun should retire

[1] Warington's *Can we Believe in Miracles?* p. 109.

behind the clouds, so that the enemy, in darkness, might be overthrown. Another theory is that this story of the sun standing still is simply an excerpt from an old poem, that we have here the language of poetry, and not the language of every-day life;[1] and that we have to interpret it according to the license of the poet, not regarding the sun and moon as standing still at all, but simply as indicating the state of mind in which Joshua was, and his earnest desire for the overcoming of his enemies. Putting aside these two theories, and not offering any opinion on the one or the other, let us take it for granted that we have here a miraculous occurrence. Immediately, the objection is raised that it cannot be true. The sun, at least, could not stand still in the sense in which Joshua wished it. For, instead of the sun revolving round the earth, we know that the earth revolves round the sun; consequently, if there were any standing still, it must have been on the part of the earth, and not of the sun. Supposing, in communicating to us this fact—the history of it—the writer had not been careful to report what Joshua said. Joshua said, "Sun, stand thou still!" Supposing he had not given the exact words which Joshua used, he must have misrepresented Joshua, for we may suppose Joshua's intelligence not to have been Copernican. But suppose Joshua's knowledge to have been di-

[1] Rev. S. Cox, *Expositor*, vol. i. p. 1.

vinely inspired, and that he consequently said, "Earth, stand thou still upon thine axis; cease thy diurnal revolution in order that I may smite my enemies!" Why, up to the time of Copernicus people would have said, "It is not true. We know that the earth does not revolve." Up to that time people would have said that the Bible contained false teaching in regard to astronomy. But, on the other hand, if Joshua spoke as he did—if we take the record as it is—there *is no confusion introduced into the mind. There is no false statement made that requires in any way to* be obviated or contended against. We have simply a record given to us of what this man desired and what he declared. We learn what Joshua said and saw. We have the facts without any statement in regard to the constitution of the solar system. And we are able nowadays, without any difficulty, to see behind the facts and understand if a miracle was wrought—I am not saying now whether it was or not—but if it was, we are able to see how it was that this might have been brought about without any contradiction whatever of the whole statement contained in the narrative.

I do not know that I am making this clear, but my meaning amounts to this: that the Bible contains a revelation in the language of the times, and according to the knowledge of the people. If God were by His revelation to give some declaration of what the solar

system is, and if it were contrary to facts, that would be a very formidable objection. But if He allows men to speak in the language and with the knowledge of their time, all the while conveying to me the exact lessons which He designs me to learn, there is neither feebleness nor falseness in the revelation. I can make allowance for the ignorance of the time and for the current language. Surely it is competent—I am speaking from a very low platform indeed—that God should leave men to interpret His meaning after this fashion, rather than that He should have confused and hindered these men in the times of ignorance by giving them a fuller light than their eyes were able to bear, or statements that their minds were not able to understand.

I have no difficulty whatever in reading God's Word in connection with the facts observable in the world around us; and I am quite sure of this, that the more closely we study some parts of the Word that we are apt to overlook, the more we find wonderful evidence —shall I say?—of supernatural and Divine knowledge. Take the legislation of Moses. In some respects it is in advance of the sanitary legislation of this year of grace 1879! The regulations of Moses for the government of this people in the wilderness were perfect for their purpose. And we are beginning to learn that some of our vaunted discoveries are merely re-unfoldings and re-issues of what was given long

ago by the hand of God's servant Moses to that wonderful people in the desert of Sinai.

I do not think I need dwell longer on this part of the subject. A full and faithful examination of Scripture, in connection with the works of nature, instead of leading men to atheism, as Lord Bacon said long ago, "bringeth men's minds about to religion."[1] It is superficial knowledge that we need to fear. The men whom we have most difficulty in dealing with at the present day are men who pick up scraps here and there that have fallen from the tables of those who are enjoying richer fare. Knowledge is always humble, and the more we know the more deeply we are convinced of our ignorance. The larger the circle of light, the larger is the circle of darkness outside. And if we could reach the extensive knowledge that Newton had, we would be inclined to confess with him that we were "like children gathering shells upon the seashore of the illimitable ocean of knowledge." And I am just as little inclined to dogmatise in religion as in science. But then I must allow God to be as dogmatic as He pleases, for He knows all, and has a right to speak with authority. And when He speaks about any matter, the question is settled. For any man to give an authoritative declaration with regard to Divine truth and moral truth, is to transcend his rights and his sphere, just as it is for any man to give

[1] *Bacon's Essays.* Essay xvi.—on Atheism.

a final utterance in regard to matters of science or nature. But for God to speak, either in regard to the one matter or the other—if there be a God—is certainly nothing that ought to surprise us, but something that we ought to welcome with the greatest readiness, and bow to with the most uncompromising submission. And I would add this—that if God gives us any revelation in regard to any matters—and I am not determining what these may be—that revelation must be the settlement of the question concerning which it is given. The fact that this Book is inspired of God rests entirely on its own independent evidence. No reasoning apart from the facts of history can touch the question whether it is or is not the Word of God: the question has to be settled independently. Is this Bible a revelation from God, or is it not? If it be, then I have here God speaking to me directly, in well-weighed words; not in symbols and dim hints, as in the Book of Nature. Men may read with more or less care and skill what God has wrought in the world. To which am I to give most earnest heed—to what God Himself tells me He has done, or to what men spell out in regard to His mode of working? When He tells me He created the world after a certain fashion, and other men come and tell me He probably created it in quite a different fashion, what am I to believe? The only argument to which I can listen is one which shall prove that God *could not*

have created it as He tells me. It is not enough for any one to say He might have done it by evolution, or by development. What you have to prove is that God's method of working revealed in the Bible is an impossible method. Until you prove that, you prove nothing.

Those who have read the *Antiquary* will remember an incident that may not be out of place as an illustration. Mr. Jonathan Oldbuck and his friend were in the fields one day. Mr. Oldbuck led his friend to a mound with a faintly-marked ditch that to him had a very great antiquarian interest. He said it had been a Prætorian camp in the time of Julius Agricola. He had bought it at the sacrifice of a large amount of arable land, because he valued its historical connections. He added: "I am quite sure of this, all the more because in digging into it we brought forth a sculptured slab having on it a sacrificial vessel and the letters A D L L, which may stand without much violence for *Agricola Dicavit Libens Lubens;* so that undoubtedly this must have been a Prætorian camp of Julius Agricola." When he had spoken, a voice behind them said: "Prætorian here! Prætorian there! I mind the biggin' o't." This was spoken by Edie Ochiltree, the king's bedesman. "What is that you say, Edie?" replied Mr. Oldbuck. "Just this, that it's nae Prætorian camp. It's a bit building that myself and some three mason lads put up about twenty

years syne, at the time o' ould Aiken Drum's bridal. Having a ploy here at that time, we built it to shelter us frae the rain, and ane o' the mason lads carved on the stane a ladle—you'll find it, if you look—and beneath it he put A D L L—'Aiken Drum's Lang Ladle'—for Aiken was ane o' the kale suppers o' Fife."[1] That was a very reasonable story of the antiquary; it *might* have been a Prætorian camp, and the ladle *might* have been a sacrificial vessel; but Edie Ochiltree saw the stone carved, and his evidence settled the whole question. I venture to say, comparing great things with small, that if we have a statement given to us by the Author of nature in regard to His mode of working, *that* comes first, and takes the place, beyond doubt, of all subsidiary statements, however plausible and probable they may be. And really, you cannot get rid of the fact of creation, adopt whatever theory you may. There must have been a beginning of events and effects, and in that beginning you must have had force and wisdom somewhere and somehow. People talk about the great fire-cloud from which was evolved the solar system; they talk of the atoms that composed it with their mutual arrangements and their mutual adaptations. Sir John Herschel pointed out long ago in that valuable *Discourse Introductory to the Study of Natural Philosophy*—a book that I advise every young man to

[1] *The Antiquary.* By Sir Walter Scott; chap. iv.

read who wants to know the principles on which nature should be studied—he pointed out long ago, before this controversy was raised, that these chemical elements found in the whole constitution of matter have all the characteristics of *manufactured articles*, and that, to begin with, the atoms themselves must have had a maker as well as an arranger. But suppose you take the whole mass of atoms that compose the material, or nucleus, of the world—how do you get the result? We have intelligences gathered within these walls; our minds are able to look before and after; and our hearts are able to have communion with things high and noble: whence come they? From nothing, nothing comes. You must have a sufficient cause for the production of any effect. Does mind spring from matter? This world, and all the existences in it now, must have had a cause somewhere in the beginning. There must have been a power sufficient to raise them up successively from lower platforms to higher; there must have been energy or power existing somewhere to produce this result. And when we take the world as it is, with all the facts of intelligence and power, nothing less, and nothing other than the existence of such an one as the Bible calls God, whom we have learned to worship as "the God and Father of our Lord Jesus Christ," can account for the facts.

How are we to study nature? Nature is but the "name for an effect whose cause is God." I have

guarded you against a false interpretation of the term. *The will of God is the nature of things.* We are told a great deal nowadays about force and about matter; and let me say that any one who is acquainted with the most recent advances in science must be surprised at the direction in which we are going. We do not know what matter is. There are various speculations about it. Formerly it was thought to be "dry, hard particles existing together in certain relations." Then, afterwards, Boscovich and others supposed that there were no such things as "hard particles," but simply centres of force. Nowadays the idea that is likely to rule the scientific world for some time is Sir William Thompson's theory that matter is simply "vortex-rings of ether." It answers emphatically to the facts that we find in dealing with matter. But when we come to the specific elements with which we have to deal, our knowledge is very limited and crude at the best. We cannot tell much about matter. We imagine that we know a great deal about force—electrical and chemical force—and so on. We know that these forces are correlated, so that we can change one into the other, and *vice versâ.* The correlation and conservation of force is one of the grandest discoveries of the present century. But what is electrical, what is mechanical, what is chemical action? We cannot answer these questions, and the terms are really no more than words expressing observed effects, having no

more behind them than Diana, Jupiter, Saturn, Mars, and other gods of the heathen mythology. They are simply terms expressing certain effects from phenomena, and the relation between them, that we have observed in our study of nature. When we come to "ultimates," we know very little. The consequence is that at the present time there is a very large school of philosophers inclined to assert that as these things —force and matter—are beyond our study, so, in the sphere of primal agency—if there be a God, as very probably there is (for they are willing sometimes to admit as much as that)—as we cannot know force or matter, so neither can we know God. We cannot see "force," nor can we see God. I have learned long ago that "no man hath seen God at any time; the only-begotten Son, which is in the bosom of the Father, he hath declared him" (John i. 18). But I can at least subjectively feel and recognise both matter and force; and I can learn a great deal about them, and can use them for definite purposes and within certain lines and limits. So I can learn a great deal about God. I can be brought into direct contact and fellowship with Him through the Son of His love, and be "made partaker of the Divine nature, escaping the pollution that is in the world through lust." As little as your scientific man will admit that he knows nothing of matter and force because he does not know *all* about them, so little

will I admit that I know nothing of God because I do not know all about Him. "Who can by searching find out God?" That is an old question, and it is still unanswered. We admit that God is beyond the range of our faculties, for the infinite must transcend the finite; but He can make us partakers of His own Spirit, and give to us His own thoughts, and fill us with His own life, and make us one with Himself, by making us one with His Son, "that we may know the things freely given to us of God."

But now to return to nature. We talk about "the laws of nature." What are the laws of nature? We must take care that this term does not conceal ignorance under the guise of knowledge, and that it does not mislead us after that fashion. Law is simply observed succession. I do not think we can predicate of it more than that. People talk about the "immutability" of the laws of nature, and raise a very strange argument from that in the following form. "The laws of nature never change; miracles are changes; therefore miracles are impossible." A very good syllogism, except that the first proposition—the "major premiss," as we call it—is not admitted. "The laws of nature never change." How do you know that? Simply by observation—not merely my observation, but the observation of men in all time to which I have access—recorded observation as well as present. The fact is, that the laws of nature, so

far as miracles are concerned, are recorded as having changed many times. The *regularity* of the laws of nature I admit; but "the immutability of the laws of nature" is a phrase to which I take very serious exception. God may at any time interfere as He sees fit. Newton said Nature's laws are "God acting in what is called nature according to accurate and uniform laws, except when it be good for Him to act otherwise."[1] The laws of nature are the expression of God's will, and nothing more. So far as we have to do with them, we have only to do with the observation of their succession. And that teaches a great deal about their regularity, but not to the exclusion of these facts that are testified by reliable witnesses who have lived before our time. I am giving this simply as an explanation. "Immutability" is not a correct term. The laws of nature are the will of God acting through matter. I make that statement with the greatest precision. I cannot recognise any *force in the whole universe except the energy that* comes from *God's will. Will is to me the ultimate of force.* I may find occasion for stating my idea of force when I come to talk about life and energy. God did not create this world, and then leave it to go on of itself, having stamped on it certain powers, and left it to their action. He is present through

[1] "Secundum leges accuratas, ut naturæ totius fundamentum et causa, constanter cooperans, nisi ubi aliter agere bonum est."

all His works. He is never absent for a single instant from any part of His dominion, doing as it pleaseth Him throughout the whole creation. *He* does not change. And it is because God does not change that the laws of nature are regular; because He is of one will and mind we can depend upon the succession of day and night, seed-time and harvest, and upon the regularity of the combination of chemical elements. Because of the unchangeableness of God's will we have the stability of the constitution of things as we ordinarily recognise it all around us. Suppose I say the sun changes. You ask me what I mean. I say that sometimes it gives light, and sometimes does not. "What do you mean by that?" "Why, it is light during the day-time, and dark during the night." "Pooh! you are turned away from the sun during the night, and of course you are in darkness; but when you get turned round again, then you have light." So a man may be turned from God and be in darkness; God may be angry with him. But the man may turn again to God, and God may be pleased with him. But God is still in one mind. It is said that He "repents;" but it is man who changes, and God remaining the same; there is an alteration of God's action towards him. Our subjective feelings condition the language which we use to express God's relations to us. There is no mutability, no changeableness in God; but there is changeableness in the

world, because of the introduction into it of creatures *having wills and purposes of their own.* And above all, by the coming into it somehow—and we are not going to raise that big question here—of sin. That has made a woful difference in the whole history of this world. You cannot study nature without studying man, and you cannot study the realm that God has created and governs, so as to learn about God, without studying the whole course and current of history, and understanding how it is that God has been dealing with it from the beginning. We may study nature after a very narrow fashion. People are inclined to do it. They look at it through certain spectacles, most carefully made, and very good for certain purposes. They are very good glasses for looking at natural things; but if a man takes them and looks at the Bible, or even at human history with them, he cannot see anything without distortion. Many physicists, for instance, speak about things of which they evidently know wondrously little. Natural philosophy does not include the whole extent of the universe, so far as I know. A man may see almost anything he expects or wishes to see. You remember Bacon's four idols—the idol of the tribe, of the cave, of the market-place, and of the theatre. A man may have the idols of the tribe, he is prejudiced by what is peculiar to him simply as man; he may have the idols of the cave, certain peculiar prejudices pertain-

ing to him as an individual; or he may have the idols of the market-place, that come from local and restricted converse with his fellow-men. A large number of men at the present day have in addition the prejudices of the school of philosophy to which they belong—the "idols of the theatre." A man who is prejudiced cannot see clearly. There is a story told by Helvetius[1] of two individuals who believed the moon to be inhabited, and, telescope in hand, were attempting to discover its inhabitants. One was a parson, and the other was a fine lady. The lady, of course, looked first, and she said, "I see two shadows, and they bend towards each other; they are evidently two happy lovers." The parson looked next, and said, "Fie, madam! for shame! The shadows you saw are the two steeples of a cathedral." Each saw what they had the power of seeing. The lady was thinking about lovers, and she saw them; the parson was thinking about cathedrals, and his vision embodied his thoughts. Our prejudices very much fashion our philosophy. It is very hard indeed to get rid of them. One who is accustomed mainly to deal with matter is very apt to introduce into other studies materialistic conceptions. When he transcends his usual line of study, he still carries with him his accustomed forms of thought. Professor

[1] Quoted in Sir William Hamilton's *Lectures on Metaphysics*, vol. i. p. 77.

Tyndall, I remember, admits that there is no evidence of life springing up spontaneously, or without previous life. Within the knowledge of men we cannot find a single instance in which life originates from anything but life. "But," he adds, "by a necessity engendered and justified by science, I cross the boundary of the experimental evidence, and discern in that matter which we, in our ignorance of its latent powers, and notwithstanding our professed reverence for its Creator, have hitherto covered with opprobrium, the promise and potency of all terrestrial life."[1] Very good, Mr. Tyndall; I have no doubt of the power of scientific imagination. But, on the other hand, suppose I said, "You may find out that you can produce life by some chemical or electrical arrangement, and you may discover that it originates in such careful arrangement of circumstances. But I can throw my imagination back to the time when, apart from all such potency then non-existent, God introduced life into the world, and communicated for the first time this wondrous potency to matter." He might fairly say that I had no right to use my imagination in that way. And I venture to retort that he has as little right to use his imagination in his way. Less right, indeed! Because, in addition to the fact that science cannot trace life except through previous life, there is the statement made in this Book (the Bible) that has

[1] Tyndall's *Fragments of Science.* Sixth Edition. Vol. ii. p. 193.

to be invalidated before it falls to the ground—that God originated living beings, and particularly that He "formed man of the dust of the ground, and that he breathed into his nostrils the breath of life; and he became a living soul."

II.

LIFE AND ITS CHARACTERISTICS.

I RECOGNISE in nature three planes of life—a lower, a middle, and a higher. In the lower we find the life of growth and development, common to all organisms, whether vegetable or animal. In the middle we find the life of thought and will, restricted to the animal kingdom. And in the higher we find the life of conscience and spiritual inspiration, restricted to the human family. Some people tell us that all these are correlated with other forces that exist already, and that are recognised throughout the whole realm of nature; that from the lowest—the nutrition, for instance of vegetable organisms—up to the highest development of life in man, we have simply gradation or degree, and that all the so-called different kinds, all action, all thought, all feeling, all emotion, all love, and all holy service, are developed from the lowest and most common elements by gradual accretion and advance. Now it is a very easy matter comparatively, if we assume in the premises all that we desire to find in the conclusion, to make our reasoning satisfactory, at least to our own minds. If we assume that

matter is very different from what we have hitherto held it to be, and that it includes in itself the characteristics of mind; and, if we assume that force has no limits, either in its operation or in its application, then, of course, it is not difficult to reach the desired conclusion, for "all things are possible to him that" so "believeth."

But when we come to deal with facts, and ask ourselves what evidence we have in regard to these statements that are so frequently made, we are confronted at once by insuperable difficulties. We find that matter is fixed, not variable, and we have been accustomed always to speak of it as having a certain property or quality that we call "inertia." But, according to the new philosophy, we must regard it as something very different—as something altogether opposite. We have been accustomed to think, also, that forces act according to definite observed laws, that there are certain conditions which qualify their action, and which we can readily recognise in the study of them. But, according to our newest developments in science, force may assume any form; and it may, without any notice, bring about changes altogether unexpected and novel. It has been said that in the domain of life we have simply physical laws acting in new conditions — that we have, in other words, modified circumstances or modified existence, and that there is no broad gulf or chasm between

dead matter and living matter, between the inorganic world and organisms of different kinds.

Examine into this subject as closely as we may, we find that there is a very marked separation between these two kinds of existence, and that we cannot possibly, by any device or stratagem, change the one into the other. Nor have we found, in the course of a very extensive series of observations, that there is any real gradational progress from the one to the other. The two states in nature—organic and inorganic—constitute separate kingdoms, conditioned, apparently, by different laws. We may, by imagination, think or conceive that there is some method of bridging the chasm that separates the one from the other, and we may picture to ourselves, after a certain fashion, the methods by which this transition may be effected, but we cannot prove by experiment that our imagination is correct, nor can we bring evidence in support of it from any other observations that we can make, or that have been made. We are met with this fact, sternly and broadly, that these two kinds of things—dead and living, as we use the words familiarly—are thoroughly distinct, and that the dead cannot of itself pass into the living. The living can pass into the dead. It ceases to live. Life vanishes. Aye, and life begins. And if we take Professor Huxley's own words, that "organisation is the product of life, and not life the product of organisa-

tion,"[1] then we have life before organisation. And I venture to add that we may have life after organisation has ceased. If we can have life before organisation, it is no argument against its continued existence after death, that we cannot follow it or recognise its continuance still. I do not found any argument on that. I am simply calling attention to the fact that, when we come to speak of living creatures, vegetable or animal, we have to do with a new force, or quality, or power—I do not care what you call it—that is quite distinct in its action from what we recognise in the dead or inorganic world.

We are accustomed to think, taking our own case, using an illustration from our own nature, that the physical organism of man is very much like some machines with which we are well acquainted. For instance, let me take the steam-engine. We have here an apparatus for the transformation of force and the employment of force in different lines and directions. We have, first of all, the coal or fuel wherewith we raise water to a temperature at which it becomes vapour. Then, by the play of the vapour upon the piston, we produce motion, that, communicated to wheels, drives the machine along a prepared road, with its load of waggons behind it. I daresay many of you remember the statement George Stephenson is said to have made. He stood at the wayside with a friend, and

[1] *Essay on Classification.*

saw one of these immense machines driven along the railway. "What do you think," he asked, "drives the engine?" His friend answered, "Perhaps a canny Newcastle driver." "No," he said, "the sun drives it." And he proceeded to explain that the carbon which gave the heat—the force employed in raising the water to the form of vapour, in which it became subservient to men—was stored up ages ago in the growing trees on the surface of the earth by the action of the sun; that it was securely stored up for us in the coal; and that we, in these times, simply set free this sun-force and use it for the production of this new motion that serves our immediate purpose. I am not inclined off-hand to accept such a statement as that, although I am aware it has become not only familiar, but very commonly accepted, in many quarters, even by men of science. For instance, we are told that the sun's rays acting on the little seed in the ground sets its particles in motion; that by the force communicated to it by the rays of the sun it begins to swell, and gradually sends its little plumule upwards and takes root downwards, and so progresses into a plant. But I am inclined to ask, would the sun change this piece of chalk into anything other than it is by action upon its particles, causing them to expand and act in this direction or that? You must have a living germ capable of expansion—a living germ that is able to avail itself of the sun's heat or energy. There must

be a certain force latent or existent in the germ which is afterwards to produce foliage and fruit. You must have two factors—an external stimulus and an internal power. You cannot get the carbon fixed in the wood by the sun alone. You must have a living vegetable organism, with its specific power, as well as the sun's action, otherwise you do not gain your coal. You must have life as well as sun. I can conceive of the sun's rays falling upon a world in which there would be nothing but death, in which no life existed, and in which those rays of the sun would be powerless to call forth any life. You must have *life*, whatever name you give it, whatever thought you may entertain in regard to its nature, you must have this specific quality, in order that, by means of any external stimulus, such as we have given by the sun's rays, you can have the product of which we have spoken. If you accept the will of God as the origin and source of all energy, I have no hesitation in correlating, after a fashion, all kinds of force, as resolvable into that one. I am not disposed to dispute any of the questions raised as to the relation of these forces, if you accept that as a primal fact. If we refer everything to the will of God, absolutely and finally, then I am prepared to admit that this will of God reigns supreme throughout all nature, from the lowest form of inorganic material up to the highest seraphim or cherubim. But when you tell me that we have nothing but physical, chemical,

and other forces in all organisms, whether vegetable or animal, and that we can explain all kinds of organic life in terms of these forces, I object to the statement, and on this ground—a very intelligible ground, and one, I venture to say, that cannot be contradicted—that we have a different force, or, if you please, a different mode of force, exhibited in all organic life, whether vegetable or animal, from that which we find in inorganic nature. Chemical laws, as is well known, are held in subjection within living organisms. I do not mean to say that living organisms are absolutely free from physical action, for we can find electrical, chemical, and mechanical action within the sphere of life. But there is a power above and beyond them in every living thing that uses them somehow for its own purposes, and directs them after a new fashion to altogether different results from those which they would reach apart from the action of that power. And if that fact does not imply that we are here dealing with a new power or a new mode of force, I do not know what facts can teach, or what language to use in regard to this matter.

Some of our philosophers at the present day are very anxious to relegate all kinds of matter and of force to the lowest forms, and to make us believe that we have a gradual rising up in the scale of nature simply from modifications in the circumstances or the introduction of new conditions. I do not know how

we can study this subject of life except by considering either the development from the beginning of one form of life, or by studying the lowest forms of life to which we have access. We can, in either direction, gain much useful information. Either we can take a germ, and, by minute observation, find out how it becomes developed into a creature after its kind, or we can take the lowest kind of organic life as it is embodied in a microscopic animalcule. In the simplest forms of life the organism is homogeneous, the whole mass fulfilling all needful functions. Higher organisms differentiate—to use a word that we find in books on this subject; that is to say, in them we have a division of labour. There are the lungs for taking in the air, there is the heart for propelling the blood, and the stomach for digesting the food, hands for working, and feet for walking. But this little lower organism is all hands, all feet, all stomach, all lungs, all heart, all everything, in one simple, uncompounded substance. It can lay hold of its food—the material that is to be converted into nourishment—merely by enveloping it (like a glove), and then it becomes all stomach internally for the digestion of its food. In its simplicity it is everything in one, just as a savage, who, if we may speak somewhat vaguely, is at once his own hatter, shoemaker, clothier, grocer, and baker. This little animal, in its own uncompounded structure, has to perform all the

varied functions for the continuance of its life that we perform by means of our several or differentiated organs.

Well, we can study life in its lowest forms in such creatures as that, or we can study it, as I have said, in the case of a germ or ovum. Let us take the ovum first. Very much valuable information has been gained by the careful study of this subject. We find that in the ovum, or egg—the germ from which, say, a dog grows — we *have first of all a crudely compounded substance. We may talk of it as a "cell." I shall have something to say about cells directly.* We have this little object—I will put it in this way—o. We begin with that. The first thing that happens is the division of this into two, as if it were cut by a knife, segmented, cut up into segments—ϕ. Then there is a division again, until we have a great many little cells in the one mass. This goes on growing, and more are added all round in different directions. Then we have a marked difference, a distinct chord or division down the central line, with certain other formations that indicate the progress that has to be afterwards made before this germ is matured into the full-grown puppy. Mr. Huxley says, I think correctly enough so far, that when we have the cell multiplied into a great many cells, made up into numerous masses, we have just the clay formed into a great many bricks[1]

[1] *Man's Place in Nature*, p. 62.

ready for the builder, so that there are convenient materials for building the tenement in which the powers of the animal are to reside.

But, then, here we have something that challenges our attention. How is it that the cell divides? How is it that it divides exactly after this fashion, and that these finished "bricks" are found with all the characteristics needful for their being built up into the structure of a subsequent life? How is it, moreover that, one step after another, provision is made for the development of the creature after its particular kind, and that there is laid down the different "bricks" and different tissues, and finally different organs, that are required for its fullest life? To my mind there is here something that passes our comprehension in the present state of our knowledge. When you have the materials prepared, how is it that the arrangement comes after this distinct fashion, so that the ovum or germ that is to be a dog takes all the lineaments gradually and fittingly and naturally that are adapted for its development into the mature animal? There is some power—I do not care what you call it—in which purpose is clearly manifested operating in this germ.[1] I am not inclined to say, as many have said in the olden time, though it has been questioned very strenuously by recent scientific writers, that there is a

[1] You have the clay, but you must also have the potter. See *As regards Protoplasm*, by Dr. Stirling. Second Edition, p. 28.

vital principle, or something that rules the germ, working definitely towards this end; that there is some invisible agent, having the intelligence and skill and wisdom requisite for all the development that is to follow. I do not need to make that supposition, and I am not inclined to make any suppositions that are unnecessary. I take this as a simple fact. It satisfies my mind, however it may appear to the minds of others, in regard to this subject, "God giveth it a body as it hath pleased him, and to each seed its own body." I cannot go beyond that. If any scientist can explain this process of development, they will find me a very apt and very willing pupil, ready to learn all they can teach in regard to this development. But I read their books and study their observations in vain. I can get no further light than what is given to us in that declaration I have quoted, with which many of us are familiar. And it is a grand and noble thing to be willing to confess that we have reached the limits of our powers, and are dependent on the revelation of higher powers than our own for further knowledge. If our eyes do not carry us far enough, we take the telescope; or if we cannot see deep enough, we take the microscope. I do not see any reason why, when our minds do not carry us far enough, we should not listen to the revelation of the highest mind—the Creator of the earth and all things that live therein—and receive, on His authority, the

fuller information that is needed to complete our knowledge. I am not using this as an argument, but simply as explaining how it is that I accept, at this stage, the simple fact that in the development of this germ we have certain processes, perfected by degrees, and that we know nothing further than that there is intelligence and purpose manifested throughout. That intelligence and that purpose I recognise as coming from above, and as somehow or other communicated to this simple form of matter by the God "in whom we live and move and have our being," and "without whom was not anything made that was made."

Next let us examine simpler forms of life. A venerable doctrine, that has not been set aside to the present day, is that all life comes from the living. Please note this. We have no life without antecedent life—that is to say, within the field of our observation. Within the limits of our observation (covering historic time): this is a fact almost universally recognised. Of course there must have been a time, if we believe that this world originated at any time, when living beings were created; or, as some others would say, evolved. I am not dealing with the question as to the *origin* of life—that remains for our consideration hereafter. I am now dealing with the question of the *perpetuation* of life. Many who would wish, and have no scruple in confessing their wish, that it were otherwise, are obliged to make this admission. They say

that in some former time it may have been possible that living creatures were formed directly from dead matter by powers and forces of nature acting in some unknown method. They confess that such facts have not come within the ken of their own observation, and by no experiment can they change inorganic or dead matter into a living organism of the lowest or of any kind.

In the earlier form of what is known as the "cell-theory" the researches of Schleiden and Schwann seemed to indicate that the cell had three constituents; viz., a structureless fluid, a cell wall, and a nucleus. This they recognised as the structural unit. Goodsir qualified this by maintaining that the nucleus and not the cell wall was the active agent in separating and preparing the secretion contained in the cell cavity.[1] Max Schultze, in 1861, observed that many cells were destitute of investing membrane, and he defined the cell as "a little mass of protoplasm, inside of which lies a nucleus."

Well, I am not going to trouble you with the development of the cell theory. You will find a very interesting and full account of it in Dr. Drysdale's *Protoplasmic Theory of Life.* It is as able and fair a statement of the whole development of this doctrine as you can find in any English book. Those who are interested in getting more extensive information will

[1] *Transactions of Royal Society of Edinburgh.* 1842.

find it in an excellent American book—Dr. Tyson's work on the cell doctrine. Speaking generally, according to the cell theory, you have a cell producing cells; by multiplication these cells become or form tissues, and thus an organism is ultimately formed. From that we have reached another theory which, I suppose, is generally recognised at the present time as the fullest and most satisfactory explanation of the development of life in its primal forms—a theory which Dr. Lionel Beale, of London, has very fully expounded in his book on *Protoplasm*, and in his other book, more instructive perhaps, in certain directions, on *Bioplasm*. In both books you will find the fullest information accessible on this subject; the latest and most satisfactory account of facts bearing on the growth and development of living organisms. The following extract from Dr. Beale's *Protoplasm* fairly and succinctly states his belief: "Not even the smallest living particle seen under the 1–50th of an inch objective consists of matter in the same state in every part of it, for it is composed of 1° living matter; 2° matter formed from this; and 3° pabulum, which it takes up.

"The matter in the first state is alone concerned in *development, and the production of those materials which ultimately take the form of tissue, secretion, deposit, as the case may be.* It alone possesses the power of *growth* and of *producing matter like itself out of materials differ-*

ing from it materially in composition, properties, and powers. I have therefore called it *germinal*, or *living matter*, or *bioplasm*, to distinguish it from the *formed material* which is in all cases destitute of these properties.

"The difference between germinal, or *living matter*, or bioplasm, and the pabulum which nourishes it, on the one hand, and the *formed material* which is produced by it on the other, is, I believe, *absolute*."[1]

We know nothing about these bioplasts, except that they have this strange faculty, at present incomprehensible, of motion and action, especially in the direction of changing the matter that is brought to them as food into their own nature, and afterwards forming the different tissues of which the body is composed. We have in this bioplast, or in this living protoplasm, the lowest form—the germinal, or elemental, form of life in the creature, whether vegetable or animal.

I daresay many of you remember that Professor Huxley, in his lecture on Protoplasm, called our attention to this substance in the common nettle, and astonished some by maintaining that it was precisely the same protoplasm which is found throughout the organic kingdom; that the protoplasm of the nettle is precisely identical with protoplasm everywhere, and

[1] *Protoplasm; or, Matter and Life.* By Lionel S. Beale, M.B. F.R.S. Third Edition, pp. 184–5.

his language seemed to suggest that, by a simple process of transmutation, the protoplasm of the vegetable becomes available for the functions of animal life. It was fully shown by Dr. Hutchison Stirling that there was just as great difference between the different kinds of protoplasm as there was resemblance, and that common sense might show any one that this difference must exist; for if the protoplasm is identical, whence spring the distinctions? A distinguished German (Professor Ueberweg), to whom Dr. Stirling sent his book, said that he was "vividly interested by its logical or dialectical leading thought—the contention, namely, for the right of the logical category of difference as against that of identity, one-sidedly accentuated, as it seems, by Huxley." Dr. Stirling replied that he (Ueberweg) had hit the mark that he (Dr. Stirling) had been simply laughing all through, and holding up to the category of identity, the *equally authentic* category of difference; but that it had taken a German to find him out.[1]

At all events, we have no difficulty in knowing that there are differences, marked and very great, between protoplasms, or between the living substances that they produce, throughout the whole domain of life. And here, again, we have the facts of purpose and intelligence. We have all this differentiation, with all these

[1] *As Regards Protoplasm.* By J. Hutchison Stirling, F.R.C.S. and LL.D., Edin. Second Edition. Preface.

results, and the value that attaches to them. We have here the action of wisdom and design. And we may not overlook the fact of chemical identity. For no one disputes that these four elements, hydrogen, oxygen, nitrogen, and carbon, are the main elements concerned in the physical framework of all living organisms, whether man, monkey, or nettle. Even in man himself there are only some fourteen chemical elements to be found in association. No one disputing this, we are, at the same time, obliged to recognise the fact that it is possible somehow for these four simple elements to produce such wonderfully diverse results as we have in the different vegetables and animals that exist throughout the world. I just ask this question: What is it that determines the difference in the results which you have from the same elements, so far as we can determine, very similarly combined? What makes the difference? It is no answer to the question to say that there are some features in common, because we know that they are not the same in consequence or in action. Along with this protoplasm we have something that is best represented by the builder and architect, powers using these different elements in different directions, and building up, according to a certain plan and definite intention, all the different forms of vegetable and animal life with which we are familiar. It will not do to say that these are simply modifications under

changed circumstances. What is the *cause* of the modifications under differing circumstances? What is the power, or faculty, or force that determines the difference in these results? There have been many definitions given of life, but it is very hard to get one that is satisfactory. There is one by Herbert Spencer that seems to gain a large amount of acceptance within certain circles. "Life is the continuous adjustment of internal relations to external relations." His explanation deals with what life *does*, not with what it *is*. Life does adjust internal relations to external relations. It does a great many things that are included in various definitions. But what *is* life in itself? It is certainly a force, a power. Is it a force similar to any of the physical forces? Can we relegate it to that category? There is no possibility of identifying it with any of these forces. The power that we find working in any of these is not adequate to the production of the results that commonly flow from life. We are compelled by absolute necessity of thought to give this force an altogether distinct definite, and peculiar name; and there is no name that can define it more effectively and beyond the possibility of misunderstanding than the simple term, "life."

Now what it does is very varied, and we have no difficulty in tracing its action in the various functions and processes common to all organisms. But I am

not going to enter on that to-night. That belongs to a subject that comes later. I am only trying to fix your minds to the question I have asked. I do not profess to be able to give an answer beyond what I have suggested. Do we know what life is? Can we classify it? I daresay you know, sufficiently at all events, the theory that is commonly called the correlation of the forces. We find that there are certain forces in nature that can be transformed in certain circumstances, the one into the other. We have mechanical force; we have chemical force; we have electricity; we have magnetism, and light, and heat. And one of the most notable discoveries of modern times is what has been called the correlation, or association of mutual interchange, between these. According to this theory all these are probably only different manifestations of one and the same force. I am not disinclined to accept that statement, if, as I said before, you are willing to admit that all force is the power of God. I am not unwilling to go further and admit that vital force may be associated with these forces in a certain fashion. But we can transform these several forces *inter se*, getting heat from light, or light from heat, mechanical power from chemical action, or chemical action from mechanical power. or electricity from both. But you cannot get life from the action of one or the other, or all combined. Life can only be produced from pre-existent life. You

cannot have life from the united action of all the different sorts of force with which we are familiar. It stands alone.

Nor do we get any help in understanding this question from any dissection or chemical analysis of the materials composing the organism. The truth is, when we put an organism on our dissecting table, or take the elements of it and subject them to analysis, and weigh them in our balances, the life is gone. Life, whatever it is, has gone from the material before we are able to subject it to examination. What we have is that which has been living—the product or result of life—it may be even, in some respects, the result of death. But life itself eludes all our tests of a chemical sort. It eludes all those methods that we use to reach inorganic materials. It disappears as soon as we endeavour to lay hold of it. A piece of dead muscle is not the same as a piece of living muscle. It has not the same qualities. You may call both protoplasm, but giving them the same name does not make them identical. The one has life with all its properties, the other wants life, and wanting life wants the one thing that distinguishes the living from the dead. And we cannot have the life communicated again to it. You may magnetise a piece of steel; you may demagnetise it and then magnetise it again; but if you devitalise or destroy a living thing you cannot vitalise it again. It only can have life

communicated to it from pre-existent life. Once communicated to it and lost we cannot have it re-communicated by any power or faculty that we possess.

I venture to say that, taking these things into account, life stands *per se*—something having a position entirely peculiar and alone. I am very unwilling to trespass on the subject with which I have to deal later on. I am anxious to fix your view simply to this fact, and to endeavour to enable you to comprehend this simple truth, that life is a force that is unaccountable in terms of other kinds of force. It is distinct and unique. It only exists by being successive to other life. It is out of our power to communicate it, or even to increase it. We cannot deal with it in such fashion as with other forces; and although in certain relations we may be able to direct it, the thing itself is absolutely and altogether beyond our sphere and control

III.

THE ORIGIN OF LIFE.

IN criminal cases in England either of two verdicts may be returned: the jury may find the accused guilty, or not guilty. In Scotland we have a third alternative: the jury may decline either to find the prisoner guilty or not guilty; they may declare that the charge against him has been "not proven." It seems to me that in scientific matters we often find it necessary to come to this alternative conclusion. We are not prepared at the first blush to say, in regard to any novel theory that is presented for our acceptance, whether it is true or not true. And for a considerable time it may be expedient that we should content ourselves with examining the proofs adduced in its support; and if we are obliged to come to the finding "not proven," we may rest contented meanwhile.

I venture to say that we have not passed beyond this stage in regard to a theory that has been very widely accepted by a great many scientific minds. I refer to the theory of evolution. I am not prepared to say that it is a true theory, and I am not prepared to say that it is a false theory; but I think I am

entitled to say that certainly this theory has not been proven.

I daresay many of you are aware that it is supposed that this solar system at least, of which we form a part, once existed in the form of incandescent vapour. This vapour, somehow or other, became condensed into such spheres as the world that we now inhabit. According to this theory, our world was at one time in a state of fusion. Then, as it cooled and became solid, the various materials of which it is composed were formed according to their general arrangement. By-and-by, through some fortuitous circumstances, life originated in its lowest forms. From these it gradually crept up into higher and still higher forms, until it found its culmination in man as he now exists. Our evolutionists tell us further that evolution is an exhaustive explanation of all the characteristics of the different animals, and of all the peculiarities of man himself. They can not only trace to evolution our physical life, but they can trace conscience, and anything that we can find higher—even our whole moral nature—to the operation of the same agency. Consequently, we are told that from this incandescent vapour, existing hundreds of millions of years ago, all things that now exist have been formed.

When we ask for proof in regard to this theory, wondrously little is supplied, but a great many suppositions, some of them plausible enough, are sug-

gested in lieu of proof. We are asked to content ourselves with these suppositions. I am going to deal to-night with one only. I purpose asking this question of the scientists: What have they got to tell us about the origin of life on this planet that we now inhabit? I shall have occasion to speak at a later stage in regard to the further development of this life in the varieties of animals and plants that are now existing on the globe. To-night we confine ourselves strictly to this question: Is there anything forthcoming that throws any light upon this question of the origination of life? I am not asking whether we can get information from other quarters. I believe that I can get information elsewhere. I believe that in a certain Book with which I am familiar I have a very large amount of interesting and reliable information on this subject. But I am only asking now what has science, or definite knowledge, to tell us in regard to this subject? I exclude, for the present, all the light that may come to us from the Bible. I take my stand on the same platform as other inquirers, and ask with them, What do we find, either in present nature or in the past history of nature, that will enable us to come to a final conclusion in regard to this subject?

We can only get information either from observation or experiment; not from the mere observation that we are enabled to exercise during our short lives,

but from the varied and numerous observations that have been made by other men through all the past centuries on the globe, so far as these are recorded for our use. Then we may make experiments, and a great many have been made in this direction, to ascertain the possibility of the production of life under present circumstances. Such experiments are entitled to very careful consideration, and if successful they must evidently possess considerable weight.

Shall I begin, then, with asking, What light is thrown on this subject from experiments that have actually been made? Up to the seventeenth century it was generally believed that a great many of the lesser forms of life sprang easily and naturally from decomposing organic materials. We are quite familiar with the fact that if meat is allowed to putrify, in the course of its putrefaction certain grubs—animals of a specific kind—will appear on its surface in very large numbers. Until the seventeenth century, it was generally believed that these, somehow, took their origin directly from the decomposing matter. It was supposed that they sprang at once, in their full life, from the material on which they were found. You will find this suggested by Lucretius in his celebrated poem concerning the nature of things.[1] It is also suggested by Virgil in one of his poems.[2] You will find it asserted in many theological writings of the

[1] Lucretius, *De Natura Rerum.* [2] Fourth Georgic.

middle and earlier ages. And I doubt not that some of us held views pretty much akin to this. We imagined that, somehow or other, these things, having life, came into existence spontaneously, without any ancestors. And if we exercised our minds about the subject at all, we might have puzzled ourselves a very long time before we could find out any other explanation of some strange apparitions of life.

But in the seventeenth century Francesco Redi, an Italian naturalist, directed his attention carefully to this matter. He found that if he put a piece of meat into a jar, and covered the surface of the jar with a fine wire gauze, then there were no grubs developed in the substance of the meat. He found also by careful watching that certain insects, attracted by the smell of the meat, came to the wire gauze and deposited their eggs there, and the eggs, not reaching the meat, were nevertheless developed into grubs. Consequently he established this as a result of his observations—that, instead of these creatures springing directly from the decomposing material, they were only hatched in it. They sprang from the eggs or germs that were deposited by the insects in it as a fitting nidus in which their young might be matured. For some time after this discovery of Francesco Redi the doctrine in regard to the origination of living things was, of course, materially altered. But by-and-by, when the microscope was improved, men began to examine the

minute forms of life to be found in certain infusions of organic matter, and they were driven to another conclusion. They formed this other opinion naturally. There are a great many minute forms of life, they maintained, which cannot possibly spring from pre-existent life; and the probability is, when we have, for instance, an infusion of hay in water, and when the water becomes surcharged with these living moving organisms, that they must have been developed somehow from the infusion itself. For a long time these creatures were known as *infusoria*, as they were supposed to spring from the infusion in which they were discovered. Needham in England and Buffon in France came to the conclusion that life originated in these cases immediately, and that, although in the case of the higher creatures there was evidently pre-existing life giving origin to new forms, in these lower creatures there was no need for any such ancestry. Indeed, to them such a supposition seemed altogether wide of the mark—something very improbable indeed. Buffon held this theory, that in every mass of matter there was an immense number of "organic molecules," that these could be developed into living creatures of different character according to the amount of life that each possessed, and that this was the rational explanation of the immense strange variety of animalcules that we find in such infusions. For instance, if I take a glass of water, I have the element of water

in a cylindrical form; the glass gives it this shape. But if I pour it out, I can either get drops or small pools of water—still water, but in another form. So, he said, we have life in the larger creatures' in a definite form when they are alive; but when they die, the life is scattered and takes on other forms, and these other forms of lower life we find in these infusions.

This question was examined still later by Spallanzani. He found that if he exposed one of these infusions to a temperature of 212° for three-quarters of an hour in a vessel with the mouth hermetically sealed, no organisms were developed. He maintained triumphantly that, the germs originally present in the liquid having been destroyed by heat, no fresh germs were formed in it so long as the air was excluded. The history of this question is somewhat minute, and I do not intend to enter into all the details. Schulze and Schwann passed air through red-hot glass tubes and through strong sulphuric acid into these infusions; they allowed no air to reach the infusions except such as had been subjected to this process, which they considered sufficient to destroy any germs that might exist in the atmosphere. And they found that in these circumstances no organisms were produced. When the same infusion was afterwards exposed to the air, abundant organisms were found in it. Schroeder in 1859 found that putrefiable materials, with certain

exceptions, when boiled and allowed only to come in contact with air passed through cotton wool, which, like Redi's wire-gauze, arrested the germs, developed no organisms. Thus scientists were gradually brought to the conclusion which Redi had reached, namely, that these living forms sprang from germs in the atmosphere; and that although we may not be able to detect them or trace their development, still if we carefully exclude them from any infusion we will have no life developed in it. The life does not spring from the dead material, but from the living germs that, somehow, have found their way into the infusion from the atmosphere.

More recently Prochet, of Lyons, instituted a number of experiments which led him to the conclusion that these observations were incorrect. He maintained that, notwithstanding all that had been said and done, it was possible—nay, he thought he made it not only probable but certain—that from dead putrefying organisms he could produce various forms of lower life. Fortunately his statements succeeded in arousing Mons. Pasteur, of Paris, to give his attention very thoroughly to the subject, and I believe that Pasteur's experiments have settled the question definitely. Not contenting himself with observing that when air was passed through cotton-wool placed in the neck of the tube connected with the bottle in which the infusion was held no organisms were de-

veloped, he took some gun-cotton, which has the property, as many of you are aware, of being soluble in alcohol and ether. He placed one end of the tube in the room, the other end being in the open air, and having established a current by mechanical means, a large quantity of air was drawn in through this tube from the outside, containing, of course, numerous germs. In that way the cotton filtered the air, catching in its meshes, so to speak, any germs that might exist. Taking this cotton, he dissolved it in alcohol and ether, and allowing the solution to remain for some time, he found a fine dust collected at the bottom. When he examined that under the microscope he discovered many organisms. In order to make assurance doubly sure, he took some of the dust and sowed it in an infusion that had been carefully bottled and corked and had given no signs of life for several months, taking care in putting it in that no air was allowed to pass in except through a red-hot chamber. He found that he was thus able to produce an abundant crop of animalcules within a very short time. Then he found, moreover, if he took the air at different heights—that is to say, opening the bottles containing the infusion carefully prepared in the laboratory, at a certain height, then at another level, perhaps a thousand feet higher, at another two thousand feet, and so on—the quantity of the animalcules was determined by the purity of the air at these

different heights. He found that the quantity of the animalcules decreased as he ascended into the purer atmosphere. Moreover he found that while on opening one of these flasks containing the infusion in the courtyard of the Observatory at Paris he had a large number of these organisms produced, on opening another number of these flasks down in the cellar of the observatory, where the air was almost perfectly still and had been allowed time to deposit its germs on the floor and walls, in almost no case were any organisms developed at all. He then made this other experiment. He took one of these bottles containing the infusion and bent the tube going from the mouth of it in a zigzag shape, and allowed it to stand. He found in this case that no organisms were produced. The organisms had got into the bent part of the tube, and, resting there, did not reach down to where the infusion was at the bottom of the flask. I think that these experiments have settled the question definitely, and Professor Huxley acknowledges it, so that "Brogenesis"—that is, the doctrine that life originates from life only—"is victorious along the whole line."[1] Mark you, these are his own words; for I claim him and Professor Tyndall as thoroughly accepting the statements that have just been made. One of the most interesting accounts of these experiments is to be found in Professor Huxley's presidential address

[1] Huxley's *Critiques and Addresses*, p. 239.

delivered in 1870 to the British Association. And another very interesting and full account may be found, as many of you are aware, in the lecture on "Dust and Disease" by Mr. Tyndall, delivered in the Royal Institution; and to my familiarity with these documents I am mainly indebted for this offhand sketch of the history. There can be no doubt that our most distinguished men of science have come to an almost unanimous agreement in regard to this subject—that life originates only from life; that all the experiments that have been made—and all the experiments, I may add, that are likely to be made—only result in proving more clearly still that without living germs we can have no life whatever.

I do not assert, by any means, that this settles the whole question. Professor Huxley does not believe it settles the question, and I would be acting unfairly if I did not tell you that he believes that somewhere far back in the past circumstances were so different from what they are now, the conditions were so altered from anything with which we are familiar at the present day, that life *might* have originated, *de novo*, from dead material then.[1] He calls it an act of philosophical faith. I venture to call it an act non-scientific. I have no doubt whatever it is an act of faith; I only differ as to the adjective that qualifies it. If we can find no evidence from our experiments at

[1] Huxley's *Critiques and Addresses*, p. 238.

the present time that life can so originate, then science is not entitled to form any conclusion as to what *might* happen under circumstances of which it has no possible knowledge. I venture to add this: I am not at all concerned, as a believer in the Bible, about this question, so hotly debated, as to the origin of life. I am not at all inclined to burden the Bible with any theory in regard to this subject. Indeed, the statement in the opening part of Genesis might easily enough, in a certain direction, lend itself to a theory of this kind. "God said, Let the earth bring forth creatures after their kind." I do not know, and unless God is pleased to give me information, I cannot know His method of working. I believe that life came from His will, but how it came—along what lines, whether immediately, or whether mediately through other existences there already, I dare not say. I leave the question, as it is left for me I believe in Scripture, entirely undetermined. I am looking at this question simply as a question of science, and I have no need to be concerned as to the answer that science may give.

Now in regard to observation. Have we any light thrown on this subject from observations that have been made in the past, or observations that are being made in the present? I daresay some of you remember that in 1868 Professor Huxley wrote a very interesting paper in the *Microscopical Journal*, in

which he gave the conclusions he reached in the examination of a specimen of sea-mud, or ooze, that had been brought home by the *Porcupine* expedition.[1] He described it very minutely, and he stated it as his belief that this mud was a plasma, or material in the process of being developed into living organic forms. He gave it at that time the name of Bathybius—*bathos*, depth; *bios*, life—deep life. In order to give it distinctness, he called it by a surname derived from an eminent scientist in Germany—Haeckel; he called it *Bathybius Haeckelii*. For a long time this statement of Professor Huxley was received with the greatest unanimity and acclamation. For, although he and others contended that it was impossible to produce life by any means at our disposal now, unless we had the pre-existing germs; they were very glad to find that nature was producing life, that at the sea bottom, some 2,500 feet under the surface, there was this great layer of plasma, or germinating material, being formed, from which life might be developed upon the surface of the earth five or ten thousand years hereafter.

Now it so happens that in the *Challenger* expedition this mud from the sea bottom was carefully dredged up and examined. I have with me a lecture by one of the scientific men attached to that expedition, de-

[1] *Microscopical Journal, Oct.* 1868. "On some Organisms living at great depths in the North Atlantic Ocean."

livered in the Town Hall, Manchester, on Dec. 11th, 1877, in which certain curious statements are made concerning this sea mud. He tells us that if we take a wineglass full of this material, and mix it with one ounce of pure sea water, and two ounces of strong proof spirit, we get a flocculent precipitate. If we take four ounces of strong proof spirit and mix it with one ounce of this substance held in solution in sea water, we get a gelatinous result. There is a difference in the result produced according to the amount of proof spirit that you add. The analysts on board the *Porcupine* gave instructions that when anything of this sort was brought up from the deep sea, it was to be carefully preserved in proof spirit. And they had so drenched it with the spirit that, instead of leaving a flocculent precipitate, they had got a gelatinous substance. It was this that Professor Huxley submitted to his examination, and concerning which he came to the conclusion that it was the material from which life in the future might be produced. But on submitting it to the investigations of a competent chemist, Mr. Murray, the member of the scientific expedition to whom I am alluding, found it was really nothing more or less than sulphate of lime, or plaster of Paris! You may guess that a considerable amount of confusion and dismay was excited in certain quarters when this result became widely known, and *Bathybius Haeckelii* has disappeared from our books of science ever since.

I notice, however, that Professor Allman, President of the late British Association meeting, ventured to resuscitate Bathybius. Not that he meant to teach that it had a real existence, but he said we must wait until we have further observations and experiments made, since the two series that have been made are conflicting. Well, we have no objection to wait, and we are quite confident as to the result. The experiments made in the second instance were made in the full knowledge of all that went before, and they were made with all due care. And we have no doubt whatever as to their satisfactoriness and completeness. Neither has Professor Huxley any very serious doubt, for at the same meeting, in seconding a vote of thanks to the President, he took care to speak somewhat slightingly and almost in an apologising manner of his own discovery of ten years ago.

Nevertheless, I may stay here to say this—that the propounding and advocating of certain ascertained facts (so called), and their burial within a very few years thereafter, is to my mind very suggestive. And it is a thing of not at all unfrequent occurrence. We have discoveries vaunted over and over again, and they die almost before they are widely known. And it is a matter of no small importance in regard to this same question of Bathybius. I am not inclined to make much of it, because if Mr. Huxley admits he has been mistaken, it is our part to take his apology,

and to say as little as necessary about the matter. I would not be inclined to say anything, were it not that many are just as confident in regard to new statements as they were in regard to the old ones, although finding meanwhile that they have done, I venture to say, a large amount of mischief.

For instance, Frederick Strauss, of whom many of us have heard, in connection with his mythical theory of the life of Jesus Christ, in his last book, published a short time before his death, stated that the chasm between the organic and the inorganic always seemed to him impassable until the discovery of Bathybius. By that discovery the chasm was bridged, and he no longer needed to think of miracle or of God.[1] I take the liberty of saying that I would not like to be the man who would give origin to any theory that would displace another's confidence, either in the existence of miracle or of God. Much less would I like to be the man who did that and afterwards found himself mistaken.

Now I hope you understand the position I am taking in regard to this question. I am not contending that life *may* not originate *de novo*. I do not ask you to give your adherence to any statement in regard to the impossibility of such origination. I simply ask you to note and remember that, so far as we know, so far as science has anything to say in regard to the

[1] Strauss, *The Old Faith and the New.*

subject, we do not find life so originating. Neither by experiment can we produce it, nor from observation can we discover anything to indicate such origin. Sometimes it is said that, although at present we are unable thus to originate life, there is no telling what may be done in the future. Chemistry, and particularly organic chemistry, is making very rapid strides. We are able to form in the laboratory a great many substances that were formerly believed to be only organically produced. It was supposed at one time that it was impossible thus to form any organic product. Now we find that a great many can be imitated by chemical processes, and it has been suggested that we may be able to originate life itself in the course of time. Well, I never cross a bridge till I come to it. I am willing to wait until the evidence is forthcoming. I am not inclined to deny its possibility. The question to me is one concerning which I am willing to wait for such information as can give me any help in answering it. But I dare to say that at the present stage of our knowledge we are forced, by the evidence presented to us, to come to this verdict, "not proven." We can find no proof, of any reliable kind whatever, that life originates in any such fashion.

Why do I lay so much stress on these endeavours to prove that life can originate thus? Simply because that proof is *essential* to this theory of evolution. The theory of evolution breaks down thoroughly if it

cannot be shown that life sprang from non-organic materials. You have a breach there that cannot possibly be filled up. The whole theory rests on this; because it is admitted on all hands, without any question, that there was a time in the history of the world when there was no life on its surface. There was a time when life began to be, and when it began to be, it must have been introduced, or it must have sprung up from existing materials. If we can show that there is no evidence whatever to lead us to the conclusion that it could spring from existing materials — such materials as then existed — and from physical causes, then we are left free to adopt the other conclusion, that it must have been introduced from without. I do not mean that we are forced to that conclusion. I must be fair, and I feel that there is no reason why we should not look at this question honestly and fairly. I say we are not absolutely compelled to believe that life must have been originated by the Creator directly, but we are forced to confess that *we do not know* that life sprang up from existing materials. And that is the one thing that it is important for us to note. And if science can tell us nothing about it, science should be silent. I do not ask more, and I will not take less. If there is no information producible from this source, and if the last word that science has to give us in regard to this matter is that it can only by a stretch of imagination

conceive that things have been otherwise than they are at present, I venture to say that science ought to proceed with other investigations giving well-defined results, and leave all these things at present where they are—outside its sphere.

I may be permitted to add here two quotations without note or comment, from Professor Huxley's article on "Biology," in the new edition of the *Encyclopædia Britannica* at present in course of publication.

"The biological sciences are sharply marked off from the abiological, or those which treat of the phenomena manifested by not living matter, in so far as the properties of living matter distinguish it absolutely from all other kinds of things, and as the present state of knowledge furnishes us with no link between the living and the not living.[1] 2. "If the hypothesis of evolution is true, living matter must have arisen from not living matter; for by the hypothesis the condition of the globe was at one time such that living matter could not have existed in it, life being entirely incompatible with the gaseous state. . . . Of the causes which have led to the origination of living matter, then it may be said that we know absolutely nothing."[2]

I need not say, for most of you are aware of it, if not all, that a great deal has been urged from this

[1] *Encyclopædia Britannica.* Ninth Edition. Vol. iii. p. 679.
[2] *Op. cit.* Vol. iii. p. 689.

quarter against the truth of the Word of God, and against even the doctrine of God's existence. I am willing to look at all the arguments, fairly raised, against the truth of the Bible, or against my belief in the existence of God. But you cannot expect that I am going to give any trouble to a further examination of evidence that is not evidence—of statements of this kind that have no actual support whatever. And yet these statements are widely spread, and unfortunately, in many instances, widely accepted. They unsettle men's minds in our day to a marvellous degree. There are hundreds and thousands who get their knowledge at second hand, from certain popular writers, and who are impressed with the idea that life is within the compass of man, and can be originated according to certain processes, and that there is no necessity for the theory of a God to explain it. Even if it were proved that we can find life, in any of these infusions, I would take exception to the conclusions that some seem inclined to draw. I would take these two exceptions. In the first place, you only get your life from material that *was* alive—organic material. You must produce your life from inorganic material, in order that the analogy may be complete. And I would make this second objection: you can only do it by the exercise of mental faculties, keenly exercised with all the power and skill belonging to the human brain in its advanced development. That is not ana-

logous to life springing up in "a fortuitous concourse of atoms" of its own accord; nay, rather that is life originated by a creator, though the creator be a human one. The truth is, *life* is the crux that meets its investigators at every stage. They fail to give us any intelligible account either of its perpetuation or its origin. It is involved in mystery. I know as little about it as the most ignorant man in the world; I will not say than the wisest in the world, because you might form a wrong conclusion from that. But the wisest man knows as little as the most ignorant man about its nature and origin. What life is remains a mystery. Science cannot tell us what it really is. I know something *about* it from the Bible. If I accept the statements there given, I learn something about its beginning and about its perpetuation. I remember a skilled botanist once told me he was surprised, when he looked into it, at the amount of botanical knowledge anticipated in the opening chapters of the Book of Genesis. The more closely, with all our extended observation and knowledge, we look into these books, the more our astonishment will grow. It takes a large amount of learning to be able to read the Bible intelligently and master the fulness of information it gives. "Every house is builded by some man, but he that built all things is God" (Heb. iii. 4). "Through faith we understand that the worlds were framed by the word of God, so that things which are seen were

not made of things which do appear" (Heb. xi. 3). I do not know it by science; it can give me no light on the subject whatever. This light it is quite possible to have. If any one says it is a false light: the credibleness and authenticity of the Bible are fairly matters of discussion. We have, then, to deal with the question of inspiration—God speaking by Moses and others in the far-back time. But either we must learn these facts from Moses, speaking in God's name, or we must pass our life in ignorance concerning them altogether.

IV.

VARIETIES OF LIFE.

WE read in a German tale that there was once a merchant of Bremen so enormously wealthy that when he heard any one preach on the rich man in the gospel who talked about pulling down his barns and building greater, he contemptuously stroked his chin, with a peculiar smile on his face. He thought that he was a petty, insignificant trader compared with himself, and no doubt there was a vast difference between the riches of the one and the riches of the other. But he overlooked the fact that the application of the parable was just as true to him as it was to the man whose case was first narrated. So there are many scientists in the present day who are inclined to look very slightingly on the knowledge that Solomon had—although we read that he talked of plants, "from the cedar that was in Lebanon to the hyssop that springeth out of the wall," and that he spake also of birds and beasts, and creeping things and fishes—because they know so many more varieties of living creatures than the wise king could possibly be acquainted with. And

yet I venture to say that their knowledge of life, of its characteristics, and of its meaning, is at least as limited as that of Solomon. And though they can classify and enumerate a greater number of forms, they have not gained a more thorough acquaintance with the principle that animates them than was possessed in the olden time.

We are still obliged to divide organic nature into two great kingdoms or classes—plants and animals. We are sometimes told now that the differences between them, especially in certain spheres, are very slight, and that, consequently, there may be bridges connecting the one class with the other. But, notwithstanding, there are at least one or two marked and essential distinctions which no discoveries that we have made have been able to obliterate, or are likely to lessen for a long time to come. Common observers, looking, for example, at the oak and the lion, notice readily enough that there is a marked difference between the tree and the animal. But when we come to deal with the lower forms of life, both vegetable and animal, we find that a great many specialties on which we depend for our recognition of either are wanting. For instance, there are vegetable forms that move about freely and readily enough in water, and there are animal forms—distinctively animal—that are fixed during the whole course of their life. Then in certain animals of the lower class we find no

trace of a nervous system; and it was supposed at one time that this was essential to animal life. A great many distinctions of like character have been, in the progress of science, obliterated, and no longer exist. But in this one respect the distinction remains as fixed and real to-day as at any time in the past; in the vegetable we have an apparatus for reduction, and in the animal we have an apparatus for combustion. Or, if you will allow the expression, in the one we have a miser, storing up; and in the other we have a spendthrift, expending that which has been stored up for him. It is quite true that within the last few months our attention has been particularly called to certain vegetable forms that are in the habit of feeding upon flesh, called insectivorous plants; the name of one has been familiar to many for a long time — the *Dionea Muscipula*, or Venus' Fly Trap. At one time it was thought that these simply grasped certain insects because they stimulated or irritated their tissue; but now it would seem, from careful observation, that they not only lay hold of the insects, but actually digest them, and digest them very much in the same manner in which we digest the food that we introduce into our stomachs. They seem to secrete a digestive juice which is able to dissolve the materials they thus apprehend. And it has been said that here we have a very distinct approximation of vegetable life to animal life. I really

do not know what use our friends are going to make of this fact, and I am unwilling to suggest any use of it. If they mean to tell us that here we have a bridge between the vegetable world and the animal world, I await further explanations and proofs. It is true we have here a vegetable that partially feeds on organised matter; but it is not the first time we have learned that vegetables feed on organised matter. Parasitic vegetables have done so for many generations, and we have been somewhat acquainted with their habits for at least several years. So that we are not learning for the first time that some vegetables feed on organised matter. Ordinarily, they feed on inorganic substances only, which they derive, to a large extent, from the atmosphere. They get a limited supply of certain substances from the soil, which they build into their substance. For instance, they get silica, a little lime, and a good deal of potash, and several other substances, though in very small quantities. But the greater amount of that which they receive they derive directly from the air. For instance, if I take a large piece of wood cut down from a growing tree, and put it into a closed retort, I get it charred. Having excluded it from the action of the air during this process of charring, I take it out as charcoal, or carbon. I find that this piece of wood, subjected to this process, is almost entirely carbon. Here I plant a little seed—say an

acorn, or any other seed. By-and-by it becomes a large umbrageous tree. Whence has it gained all this? We find the greater part of its structure is simply carbon or charcoal. It has gained that from the air. It has taken the carbonic acid gas, and decomposed it, retaining the carbon, returning the oxygen. So I have said that the vegetable is an apparatus for reduction. It reduces—this tree I am speaking of—the carbonic acid gas it receives from the atmosphere, keeping the carbon, and returning the oxygen for which it has no use. And it gives us, in the form of fruits and of seeds and of roots, the materials that we use afterwards in our bodies for fuel, and in the production of heat and force. We take the materials thus stored up, and spend them for the accomplishment of our own physical purposes. Generally speaking, then, I repeat, the vegetable is a reducing apparatus. And even in the case of these insectivorous plants, when the matter is fully discussed and explained, we will find that this principle of action is not departed from.

At all events, *animals* feed upon organic substances. To this rule, I believe, there is no exception. If we could get the materials that are required for the nourishment of our bodies, and of which these bodies are composed, from nature in a simple condition, we would have no difficulty about being fed; we would have no anxiety about the prosperity of the

country. We would not need to care much how its business was carried on. Our bodies are built up, as I have already told you, mainly of these four elements—hydrogen, nitrogen, oxygen, and carbon. These exist very widely in nature. A chemist can produce them in unlimited quantities, and it would indeed be a good thing for this country if the chemical activity of which we are told[1] could furnish all those things that are required for our physical support. But unfortunately we cannot feed on these things in an uncombined form. We must have them built up into organic forms before they are of any service. They must pass either into the substance of vegetables or of animals before they are fitted to nourish us. They must undergo a certain change before they are in the condition in which they can be profitable for our physical well-being. Animals are always spending the force collected for them in what we term the plant world. There is a remarkable balance between vegetables and animals. I remember with what delight I read, a great many years ago, a very interesting lecture on this subject by a French chemist.[2] Then I had the idea to which I am now giving utterance first suggested to my mind, and learned with great interest of the wonderful adjustment be-

[1] Lord Beaconsfield had spoken of increased chemical activity.

[2] *The Chemical and Physiological Balance of Organic Nature.* By M. J. Dumas and M. J. B. Boussingault.

tween the two kingdoms that God had instituted from the beginning—how our breathing would soon pollute the whole atmosphere with carbonic acid gas, were it not that the plants take it up as we expire it, keeping the carbon and returning us the oxygen, we also, of course, giving them the material they require for their life. I should like to learn from the evolutionists which of these two kingdoms was first, or if they were both evolved together. They are very reticent in regard to this transition from the platform of vegetable life to that of animal life. I have looked with a good deal of care into certain treatises quite recently to find some references to this stage in the development of life, but I find very little indeed about the position that vegetables occupy in the process. I do not know what use they may be going to make of the insectivorous plants; they have not made any use of them in this direction yet. They may have some information to give us in regard to them for which we are not at present prepared. But as yet we have no statements made that are at all satisfactory or helpful in regard to any supposed progress from this lower stage of vegetable life to the higher stage of animal life. Indeed, from the remarks I have made, you will at once perceive it would be very difficult to trace the progress from the vegetable to the animal kingdom, and such evolution would be open to very serious objection.

There are a great many varieties of animal life and vegetable life to which I cannot hope to call your attention in the course of the brief time allotted to me here. If any one is interested in the curious features of both, and particularly of animal life, I cannot refer him to a better guide than *Gosse's Romance of Natural History.*[1] You will find in these two volumes a great many very interesting facts with which naturalists are familiar, and a great many of what may be called the sports and curiosities of nature.

When men first study the varieties of animal life—let me come particularly to this—they notice the very marked *differences* between different creatures. I suppose in the regular process of education, whether historical or individual, there is invariably this method. We notice, first of all, distinctions. The older naturalists spoke of mammals, and birds, and reptiles, and fishes, and insects, and worms. That division really summed up all that they observed in their study of nature. For practical purposes that division was sufficiently explicit for many years; but as men began to range more widely, and to examine more narrowly, it was discovered that there are a great many creatures that could not be conveniently classed in any of these divisions. Various classifications of different kinds have been proposed in one age after another

[1] Gosse's (P. H.) *Romance of Natural History*, 2 vols.

that would be tolerably sufficient to embrace the whole of the animate creation. I do not know any better classification than that which M. Cuvier has given. I believe that substantially it stands, and will stand. Von Baer, who examined the subject embrologically, really adopted his classification, although he gave the different classes other names. Cuvier's division was fourfold (beginning at the bottom)—radiates, mollusks, articulates, and vertebrates. Each of these has its own distinct formation, and although there are great varieties within each class, they are each formed on one plan, and these four plans are found fairly to cover the whole animal creation.[1] Von Baer spoke of radiates as PERIPHERIC. These terms differ very slightly. In the one case the parts are regarded as *radiating* from the centre; in the other as *converging* to the centre. Von Baer classes the mollusks as MASSIVE, the body being undivided and soft, without individualisation of parts. You may take the star-fish as a representative of the radiates, and the oyster as a representative of the mollusks. Then the articulates are represented by the varieties of insects, and the vertebrates by fishes, reptiles, birds, and men—creatures having a backbone. Von Baer called the articulates LONGITUDINAL, and the vertebrates DOUBLY SYMMETRICAL. So that there is really no difference, although Von Baer's mode of

[1] Agassiz, *Methods of Study in Natural History*, p. 26.

examination and study was markedly different from that of Cuvier. The German naturalist examined them in connection with their development; the French naturalist simply looked at their morphology and physiological action. These two great naturalists arrived at the same conclusion: that we have four leading kingdoms in animate nature, and each of these has its several sub-classes or divisions. Each has its own definite plan, that is not confused in the least with the plan of the others.

Sometimes we hear it said that there is evidence of progress from one to the other. Evolutionists are inclined to teach that radiates reach the mollusks, then the mollusks reach the articulates, and so on, until the summit has been gained, and the evolutes become vertebrates. Undoubtedly we have these four classes. They stand like steps in a ladder, or like the large steps that lead us up to the top of a pyramid. But it is one thing to find them *gradually* approaching each other, and having definite relation in succession one to the other; and it is quite another thing to believe, or prove, that they have a *genetic* connection one with the other. That is to say, that the radiate can *pass into* the mollusk, or the mollusk into the articulate, or the articulate into the vertebrate. They are related to each other undoubtedly; they have a *gradual* connection with each other; but I want you to note that there is no proof

of their being so connected as if one class sprang from the other by historical birth or development, until we reach the highest. And it is *that* connection that has to be proved in order that the doctrine of evolution may be established as true. Sometimes we have heard it said—of course by those who do not know much on the subject—that the human ovum passes exactly through all the three stages in the course of its development into man. That is simply not true. It has something corresponding to the different classes of the vertebrates. At one time it resembles a fish, but it is not a fish. At another time it resembles a reptile, but it is not a reptile. At a third time it may resemble a bird, but it is not a bird. It is always distinct and peculiar, although it has certain forms that an unskilled observer might suppose classed it with either of these lower divitions. As I have said, four distinct types exist throughout nature, and exist uniquely, although we find several subdivisions in them. But each one has a distinct type of form and plan, and is always determined thereby in development as well as in appearance.

You are quite well aware that Mr. Charles Darwin—(applause)—I am glad to hear that applause, because Mr. Darwin is a very distinguished man. I would be the last to say a single word that would derogate from his high scientific position. I do not know any more

interesting or fascinating book than his book on the *Origin of Species*, although I do not at all agree with his conclusions. It is one thing to differ from any one in regard to his reasoning on a subject, and another thing to set up oneself as being equally competent. As an observer, Mr. Darwin occupies a very distinguished position among naturalists, and there are a great many things in his book that will live, I think I may safely say, for generations yet to come. But I do not think his theory will live. I do not think his mode of explaining the origin of the different forms or varieties of animal life will be accepted much longer. And I intend to give you what I think is sufficient and satisfactory reason for this statement.

I will confine myself to-night, of necessity, simply to what we know by the study of nature as it is submitted to our personal investigation. I have nothing to do, at present, with the *record* of life. That awaits our study hereafter. The record of life is in books, or in the stone-books that are embedded in the earth. To-night I have only to do with the facts observable throughout the range of nature open to our present study.

I am quite willing to admit that if Mr. Charles Darwin's theory were true, or if there were reasons for accepting it as true, it would explain several things for which, at present, we have no explanation. I am quite willing to believe that, if we had

good ground for accepting it, we would find it valuable in giving us information with regard to certain matters on which we have no knowledge. But then, mark you, we must have the thing itself established on sufficient grounds before we can employ it in that way. We have first to ask: Are there facts, known to us, that demonstrate the truth of the statements that he makes, as inferences from his observations? I suppose you know well enough the leading features of this theory. But before coming to that I may say that it is confessedly well known that many who are classed as Darwinians are really not so. There is Darwinism and Darwinism. There are a great many different kinds of Darwinism, at least as many as there are of animals—four distinct varieties at least, and quite as different from each other. Very long ago, as some of you are aware, we had a theory current in this country through the plausible teachings of a very celebrated book. That book, *The Vestiges of Creation*, was just an importation of Lamarck's theory, with certain additions adapted to the particular time in which the book was published. Lamarck's theory really amounts to this. That animals have a certain appetency; they have desires which develop, by use, certain organs; so that they become gradually more and more capable of doing what they wish or long to do. For instance, the giraffe—this is a typical instance—wanting to feed on the higher branches of

trees, stretched and stretched its neck again and again until it got elongated! So ducks, wanting to swim, begin to paddle in the water, and gradually developed certain membranes until they got webbed feet! I think there is a great deal of truth underlying this theory, although it seems so absurd. And indeed there is truth underlying all the theories, and I would go a certain length with them all. It is quite true that organs may develop by use. Then another theory is that of Herbert Spencer, that organisms are modified by their surroundings. You remember his theory of life, "a continuous adjustment between internal and external relations." He says that organisms are modified by their surroundings, as men who live under a tropical sun become dark men, and men who live in colder regions became blanched or white. *Organisms are thus developed into different forms by the circumstances that surround them, or those* under which they live. And he would explain evolution, indeed he attempts to explain it, through his many learned philosophical treatises on this principle of *modification by the environment.* Then we have what may be called the theory of *derivation*, formulated and advocated by Professor Owen. He holds that in animals there is a *tendency*—given to them, as he indicates, by the Creator—to improve in certain definite directions. In the process of time, through the action of this tendency, the animal attains a higher position.

I am inclined to accept, so far, and within certain limits, both the *appetency* of Lamarck, the *modification* of Herbert Spencer, and the *derivation* of Professor Owen. Lastly, we have the theory of Mr. Charles Darwin. According to Mr. Darwin, like produces like, which gives us the law of heredity; the likeness produced, however, is not exact or uniform, and thus we have the law of variation. More animals are brought into existence than can be provided for easily, which suggests the law of increase; then, maintenance of life becomes difficult, giving us the law of competition; and finally, the weaker succumb while the stronger survive, which may be expressed as the law of the survival of the fittest. By the operations of these laws through vast cycles of time species have been transformed, and we may trace the development of the highest organism from the lowest.

Now I have no disinclination to accept these statements, *cum grano*, with a certain big pinch of salt. But the question is not as to how far *varieties* may be produced from appetency, which may develop an organ and make it strong; or from circumstances which may even modify structure; or from upward tendencies that may issue in improvements; or from struggles for existence which may, in some instances,[1] develop nobler and better qualities. The question is

[1] Among men the struggle for existence does not always develop good qualities.

Can these separately, or even in combination, *change one species into another?* Do not be misled by any number of varieties that may be produced by one or other of these, or by all acting together. The question is, Have we any evidence before us that by these means we may have an entirely different species produced from one already existing? I am not speaking for myself, but for almost all the physiologists and naturalists who have really studied this subject and examined it honestly, when I say that no such evidence can anywhere be found. And I maintain that the absence of such evidence invalidates the theory of evolution. Mr. Darwin tells us about what has been accomplished by the art and skill of pigeon-fanciers. I suppose they have produced somewhere between one hundred and two hundred varieties. We have pigeons with short bills and long bills, with large feet and little feet, some with thirty or forty feathers in the tail, and others with thirteen or fourteen. We have tumblers, and pitchers, and fantails, and carriers, and trumpeters, and all kinds of pigeons. All these varieties have been produced by interbreeding. The fanciers have noticed certain peculiarities in some of their flock, and they have carefully intercrossed them, so as to perpetuate and advance along the line of the peculiarity they wished to secure. But they have found that if these peculiar breeds were let loose and allowed to go as they pleased, they would not long maintain their

peculiarities, but would in a few generations revert to their original character. I wish to call your attention to this fact, that in the first instance these varieties have been produced by careful interbreeding, with the superintendence of an intelligent, purposing mind. In my judgment, this fact is a very important one. Mr. Darwin speaks about "*natural* selection." He almost deifies nature. He makes this natural selection perform most wonderful things. Have we any evidence in the whole sphere of our observation that *natural* selection acts in this way to any appreciable extent whatever? Understand, I am not dealing here with the question of species, but only with this question of varieties. For instance, take the case of European animals introduced to South America by settlers—take the horse, the sheep, the dog, or the cat. These being allowed to run loose and get wild lost all the peculiarities they had by domestication, and returned to the original type that belonged to each. We have this result—not advance, but retrogression—by natural selection in every instance. Well, I take exception to the term "natural selection" on that ground. And even admitting that in nature there may be a process similar to this that man directs, the next question is, with all this intercrossing and interbreeding, have we developed anything at all approaching to another species? With all your varieties of pigeons, have you changed a pigeon into a crow? It is vain to tell me

you have these differences. What I want is, not something that is still a pigeon, but something developed from a pigeon that has lost all its pigeonal qualities and gained others. With all your crossing and intercrossing of dogs, for instance, you may produce wonderful variety, but that is not the question. Will you produce something that a mastiff or any other dog could not at once recognise as belonging to its kindred? You produce no variety of species, but you produce an immense number of *varieties within the species.* I do not think we have given heed to the possibility and extent of these variations as we ought to have done, and we owe a debt of gratitude to Mr. Darwin for pointing them out. Variation will proceed very far, and probably we have classed a great many different kinds as species that are simply varieties, and not species at all. And the sooner we have correction made in these terms the better. When you get true, distinct species, they are really different physiologically and anatomically. You cannot make one pass over to the other. Nay, more than that, you cannot take the first step by making something between the two and perpetuating that. Suppose it were possible to take that step, as some have been trying to prove, I would not admit that as a settlement of the question. Suppose you have to cross from this point to that point, twelve inches distant. You say you have come midway within six inches of the starting-point and the

goal. That is not enough, you must advance over the whole distance. So you may produce something between two species—neither the one nor the other—but that does not prove that you can change the one into the other; nor am I prepared to admit that it is a new species. But you cannot even produce something between the two, an intermediate species capable of perpetuation. You may, with a he-ass and a mare, have as the result a mule, or (what we do not often see in this country) you may have, between a stallion and a she-ass, what is called a hinny. Even then you have remarkable differences. A hinny, for example, neighs like a horse, while a mule brays like an ass—they are different from each other. You may have this middle thing, but you cannot perpetuate it; you must go back to the ass and mare for the production of fresh mules. You can get hybrids, but they are not another species, and they are not fertile. You must revert to your original factors and have a repetition of the process if you would multiply your hybrids. I hold, without going further, that that is conclusive against Mr. Darwin's theory. We do not know of any possibility of crossing this line, or chasm, from one species to another. And if there were evidence that it could be done by most skilful appliances and methods, I would still ask for evidence that nature was in the habit of doing it. I shall show, I hope clearly, when we meet again, that we have no such

record in nature throughout the long past to which we have access. All the records that have been searched give no evidence whatever on this subject that is worth considering. The truth is, that there is plan in nature throughout, and that plan is the expression of God's idea. I cannot tell you in every case why He has done this rather than that; I have simply to accept the facts, as wise naturalists always do. They make advance in science by doing that, by believing that there is a wiser mind than theirs, and that their best knowledge can be gained by studying the expressions of that wisdom simply as they are presented.

Now Mr. Darwin's theory, as he has given it utterance, *in my judgment*, is essentially atheistic. I do not think he would accept that as a fair statement himself, but I am not giving my judgment in regard to the man, but in regard to the system. Those who carry it out fairly and honestly—*e.g.*, Carl Vogt, Büchner and Haeckel—are atheists. One has said this theory of Darwin's turns the Creator out of doors. Professor Huxley said that when he first made acquaintance with Mr. Darwin's books, he found that they put an end to the design argument, or teleology, as he calls it; Mr. Darwin gave it the death-blow.[1] I know that all Darwinians are not atheists; far from it. There are many devout Christian men who believe in the doctrine of evolution. But, in my judgment, and you can take

[1] Huxley's *Lay Sermons*, &c., p. 330.

that for what it is worth, the Darwinian theory, carried out logically, has an atheistic tendency. On that account I do not fear it, but I must say on that account I do not like it. And I think I have as good a right to dislike whatever takes that form, as scientists have to be prejudiced against the Bible, if it does not happen to agree with their notions. Many people are prejudiced against the Bible because it does not agree with what they think is true in this matter or that. Very well; I have reason to be prejudiced against that which contradicts what I know to be true in my inmost soul, not by my own knowledge, but by the revelation of the Holy Ghost. Only I would not allow that prejudice to hinder my study of the question, or to prevent my examination of any arguments that may be adduced. Indeed, the very strength of my convictions makes me fearless in examining contradictions. And I am glad to be able to say to you that, as yet, there is no evidence whatever forthcoming to give just cause of alarm to the most timid. The possibility of producing one species from another has yet to be proved. Professor Huxley has himself confessed, in dealing with this subject, that this gulf is at present impassable.[1] Hybridity —the infertility of hybrids—sets up a barrier that is impassable. It remains there, fixed and certain, and prevents us from making any progress in that direction.

I close this lecture simply by saying that I have en-

[1] Huxley's *Lay Sermons*, &c., p. 323.

deavoured to deal only with one aspect of the question, viz.—its relation to facts of present observation and experiment. It is better that our minds should be fixed on that, so as to ascertain precisely and clearly how it stands. We will then be prepared to consider further what we can learn from the records of the past.

V.

THE RECORD OF LIFE.

IN the year 1798, Napoleon Buonaparte, with his army, entered the town of Denderah, in Central Egypt. There he found two interesting and seemingly ancient temples. From one of them—the smaller—the roof, carved with certain figures, was carefully taken down, and carried to Paris. When examined there by learned men, it was found to be what is technically termed a zodiac, and, from certain marks, they inferred that it was at least seventeen thousand years old. Soon after this discovery, and under its influence, a Professor in the University of Breslau wrote a book with the title, *An Invincible Proof that the World is at least Ten Times Older than Moses supposed when he wrote the Book of Genesis.* Many believers in the Bible were very much startled by this discovery, and for a time they were in much fear of mind. But some time later Champollion discovered the method of reading such inscriptions as were found on this zodiac; and when he carefully examined it, he discovered, among other things, the name of Augustus Cæsar inscribed upon it, proving that it was not older than the Christian era!

Several years ago Mr. Horner went to Egypt to investigate the rate of deposit in the Nile valley. He calculated that a very small number of inches was deposited, in the form of mud, each century. In digging down through the mud he brought up a piece of pottery from a great depth. On calculating the number of feet, and reducing them to inches, he came to the conclusion that this piece of pottery was ten or twelve thousand years old. Of course that proved the existence of man with the capability of framing such pottery, many thousands of years before the creation of Adam! Later still, however, a piece of burnt brick, undeniably Roman, was brought up from a lower depth, proving that Egypt had been subjugated by the Romans a great many thousands of years before Rome became a nation! We are all familiar with the fact that, not many years ago, objections were urged against the Scriptures, on the ground that such cities as Babylon, and particularly Nineveh, as described to us in the Book, could never have existed; but Layard, Rawlinson, and others, having dug into the ruins of these cities, have proved that the biblical account is exactly true. At this present moment the discoveries that are being made by archæologists of libraries, the leaves of which are clay slabs with cuneiform inscriptions, are all tending to establish the veracity of the books of Moses and the prophets. Where we can bring definite light to

bear upon this Book that so many of us reverence and trust, we find that its statements are worthy of credit. I am not advancing, at present, any argument in support of its inspiration—that is altogether outside the question — but the trustworthiness of the Book, in regard to the facts which it mentions, is being established every year more and more conclusively.

I venture to call your attention to these mistakes, because I wish to hint, in as gentle a manner as possible, that when we begin to calculate time we are very apt to make such blunders. I do not know any question that is more hotly debated among geologists at the present time than this question of duration. Sir William Thomson stated, on astronomical and physical grounds, that the existence of the solar system must be limited within a very large number of years—amounting to many millions. But that time is not sufficient for our geologists of the evolutionary school. They have been fighting most strenuously against his conclusion, in such ways as they possibly could, since that conclusion was stated. The truth is, that calculations in regard to geological time are necessarily uncertain. We can have no absolute time unless we have dates. When we get into the prehistoric era we can only have relative time, and all our conclusions in regard to relative time must be characterised, more or less, by this element of uncertainty. The reason why evolutionists are

anxious to secure unlimited drafts of time is to be found in this fact: that they cannot discover such processes now taking place, in any appreciable degree as must have taken place in order that their theory of evolution may be proved true. As the rate of progress must be excessively small, they can only expect us to receive their doctrine on the supposition that there must have been indefinite time for gradual indefinite accretions. Now it would be as easy to account for all the things wherewith we deal by drafts on the bank of force as by drafts on the bank of time. Give me force enough of the right kind, and I can produce all the results in an inconceivably short time. Nay, more than that, time does nothing. Time is merely the opportunity for force to work. And it is this question of the forces at work that we have to settle, in order to come to any satisfactory issue of any kind whatever.

I make these remarks because to-night we are going to deal with the record of life. And that record, as brought before us for our study, is not confined to the historical period. Geologists and palæontologists, in following the history of the earth and of ancient creatures now extinct, have of course to go far beyond the historic era. I am not going to raise the question now—it does not lie within the limits of the present discussion—as to the dates, or in regard to any matters connected with the dates, of the existence of

these extinct animals. I believe we are not prepared, at this moment, to come to any sound conclusion on that point. A great deal more must be done before we can have even the elements furnished to us for arriving at a proximate conclusion. Therefore I do not deal with that question beyond saying this: that there are many who accept the first three chapters of the Book of Genesis who are quite willing to allow that the material of this earth, and certain forms of life upon it, existed for thousands of years before the creation of man. And they have no scruple whatever in allowing a very long time for the deposition of the different strata, including in them different organic remains. Dr. Chalmers pointed out long ago the indication of a break between the opening verse and the succeeding verses in the first chapter of Genesis. And that break may allow millenniums—thousands of years—between the beginning of the creation and the subsequent process by which the world was furnished and fitted for the habitation of man. Indeed, there are many theories devised—I do not attach much value to any of them—in order to bring the opening of Genesis into full relation with present science. I mean by saying that I do not attach much value to any of them, that we have not got the scientific materials that we require to have, before we proceed to lay them alongside of the account in Genesis and find out whether or not

they really agree. I am content to wait till we have these supplied.

You are aware, from our discussion on the last occasion, that no evidence has been adduced—no evidence of any kind whatever—that it is possible to transmute one species into another as things are at present. The barrier between the species is an impassable one. Our wisest biologists, with almost no exceptions--I may say with no exceptions of any account that I am aware of—make this admission freely. Professor Huxley makes it without any hesitation. The barrier between distinct species is, so far as we know, in the present era, utterly impassable. The question is, having arrived at this conclusion, in what attitude are we to stand, and with what peculiar state of mind are we to contemplate the record given to us, either in history, or in the rocks? I venture to say that we are at least entitled to demand, if we are to believe in this transition from one species to another, that there must be clear evidences of the transition produced. If we found that with our present means and methods of experiment we could change one species into another, then we could carry that probability with us in examining either past history or the record of the rocks. But when we find that there is no such evidence forthcoming, we must rigidly demand exact proof either from history or from the rocks, if we are called upon to admit the

possibility of such transmutation in past times. I make that statement especially because, as many are aware, Mr. Darwin dwells on the imperfection of the geological record. I have known for a long time that it was imperfect—I believe some years before Mr. Darwin published his book; and it is not at all a novelty to me. But it certainly came upon me with considerable surprise when I read it for the first time in that book. I was inclined to say (soliloquisingly): Some of us have been doubting the conclusions that men have been drawing from the records of the rocks, and we were inclined to bid them give pause, and not proceed so rapidly in their judgments; but we were silenced by the statements that these facts were indubitable; that they were so numerous and complete that there was no possibility of questioning them. But here a new Daniel comes to judgment, and tells us that his theory can only be established if we admit that the geological record is necessarily, and to a very considerable extent, imperfect!

I have had very great doubts, and I have still, in regard to this geological record. I believe that in the rocks we have a specific record of death, and not of life. I draw a distinction between these two things simply on this ground—that the forms that are embedded in these strata are not necessarily a full representation of the actual forms that lived during the time when the strata were being deposited. The

records of our churchyards and the records of towns are very much alike, because we bury all our dead in the churchyards. But the records of mud at the estuary of a river or at the bottom of the sea are not parallel with the fauna and flora to be found in the fields and on the mountain-sides from which these layers of mud are drafted. Many forms escape; many organic forms are devoured by other organisms, and in various ways—by the action of the air and otherwise—perish, without leaving any trace behind. I have looked with great care into many treatises to find some light upon it, but it is very hard to say in what circumstances exactly many of these forms have been so preserved to us. It would be apparently easy for us to imagine how a plant or animal might be *suddenly* embedded in a layer of mud, and afterwards fossilised; but it is hard to think, on the supposition that these layers of mud are formed at the slow rate of two or three inches in a century, how fishes, so notoriously perishable, and so apt to be devoured by other denizens of the deep, are preserved exactly, even to their very scales. I wish I could get more information how these fossils, and especially certain fossils with which many of us are acquainted, have been so thoroughly preserved. In many instances it would seem as if they were overtaken in some great catastrophe. The very writhing of their forms as they lie in the stone tells us of

sudden, strange, and startling death. I do not suppose that geologists would be ready to admit that this is the general history of the formation of fossils; but how, in the ordinary slow process which they postulate for their formation, they could have been preserved so exactly that we have the full details of the form given to us is a puzzle to me, I confess, and is likely to remain one for a long time.

Still, speaking generally, and with that explanation, we may take the rocks as containing for us the record at least of some part of the history of the past. Well, then, what do they tell us? Have we transitional forms in them? Mr. Darwin admits that we have not, and he gives several reasons why we cannot have such transitional forms. I admit that there is a great deal of force in some of his reasons if there were preliminary probabilities in their favour. If we could prove that species are transmutable now-a-days, we would be prepared to listen to arguments from the imperfection of the geological record. I admit, as I say, the force of some of Mr. Darwin's statements. They are very ingenious, and their ingeniousness would have value if we had reason to believe, apart from them, that such transition was possible. But to my mind the ingeniousness goes for nothing when we have no reason to believe that it is possible. And the ingeniousness is merely exercised to show that we cannot expect to find the answer anywhere else.

Lately, I admit, an attempt has been made by Professor Huxley, in his lectures in America,[1] to prove that there has been a transition. Certain transitional forms of the horse have been discovered by Professor Marsh in America. These remains, I believe, are in the University of New York. Professor Huxley contends that we have in these a distinct gradation from a less perfect to a more perfect form, particularly in the formation of the bones of the leg. Well, he attempted to prove that these animals were related genetically—by birth or descent—the one to the other. He represented them all as of very much the same size, whereas it was said that one of them was no bigger than a fox, and ought to have been so represented in the diagram. Of course it makes a great difference if that statement is correct, because the horse is not at all in size like the fox; and it is an element not to be left out of account in making any investigation into such a subject. But I do not insist on that. I am quite willing to take the facts as he gives them. But I understand that Professor Dana, of New York, one of the most eminent geologists—perhaps the most eminent—in America, who has these bones in the museum of the University to which he belongs, does not believe in the transitionalness of these forms. And I find, moreover, that Professor Nicholson, of Durham University College, denies that these

[1] *American Addresses.* By Thomas H. Huxley.

forms afford the proof which Professor Huxley claims that they do. So that we have opposed to his view, on the one hand, Dana, a geologist, and on the other, Nicholson, a zoologist, and both eminent men. And I do not think that since the delivery of these lectures we have heard a great deal about the development of the horse, which to my mind is a very suspicious circumstance. Mr. Huxley claimed that this was a demonstration—I am using his own words—of the truth of evolution. But if it had been a demonstration, depend upon it the welkin would have been ringing with it in England since then a good many times. For my own part, simply reading over Professor Huxley's account, I am not inclined very much to question the possibility of such a development as he represents. I am speaking, of course, simply of such knowledge as I have derived from the perusal of his own lectures. I refreshed my memory by reading them again to-day, and I have read them, I suppose, two or three times before. So far as I can judge, I confess I would not be at all unwilling to admit this evolution of the horse. Nay, I find that Professor Owen in 1852—a good many years ago—suggested that, on the derivative hypothesis, the hipparion, one of the animals in question, might be the link between the paloplotherium and the modern horse, so that it is not by any means a new explanation of the facts.[1] You

[1] See Owen's *Palæontology*. Second Edition, p. 398.

will remember that I said, in a former lecture, that I am quite willing to allow for the action of variation to a very large extent—an extent only to be determined by careful examination. Species can vary very considerably within limits, it may be within very large limits; but that does not at all prove that one species can pass into another. And if one kind of horse—I am speaking simply from the description as Professor Huxley gives it—of an imperfect structure in the past, has been evolved—I should say by special provision, at any rate has been evolved—into a more perfect form, there is nothing in that to startle anybody. I do not admit it, and I do not deny it. But that one horse of a less perfect type should in the process of time, by some means or other, become more perfect in the formation of the bones of its feet, is not at all a demonstration of the truth of evolution. I do not suppose any one would deny that there is a certain measure of truth in the theory of evolution or development as applied to the Bible. There is a gradual progress in the knowledge God gives to us there concerning Himself and concerning His will. There is progress or development, call it what you will, in the history of every civilised nation; but that is not transmutation. Beyond what I have indicated, I am not aware of any evidence adduced in order to establish the assumption that there has been any transition in the past. But I am acquainted with a considerable

number of facts that seem directly in the teeth of any such supposition. For instance, Hugh Miller has said, and I am not aware that his statement has been disproved, that, "in the great procession of life the magnates walk first." Instead of the lower forms beginning at the bottom of the scale, and raising themselves to a higher position, and becoming more perfect and complete, in the history of the strata we find that species begin in their full completeness; gradually they are degraded and die away. We have the history of degradation in the rocks, not of evolution; of backward, not of forward progress. Away down at the bottom of the scale we have representatives of all the four classes—radiates, mollusks, articulates, and vertebrates. When we come to the fishes of the Devonian era, we find peculiar forms of aquatic life highly developed and perfect of their kind, having no predecessors and no true successors. The truth is, in the whole record of the rocks we find that there have been distinct species at different times, appearing suddenly and vanishing away; and these appearances and disappearances have been repeated over and over again. Cuvier had these facts present to his mind when he wrote his book on *The Revolutions of the Earth*. He distinctly faced this question; and supposing that it might be asked whether or not it was possible to explain the origin of species by their development from lower forms, he gave it an emphatic

negative.[1] It is not at all a new idea, only it has been developed by Mr. Darwin in a new form. It has been again and again suggested, and as often rejected, by the best naturalists who had all the facts before them.

Then, again, if we are to have this theory established, we must have evidence that there is not only this gradual advance to perfection in the raising of one species from a lower form to a higher, but there must also be the gradual perfecting of the several organs and faculties. These present puzzles that have been studied very carefully by evolutionists, but I venture to say that they have never been able to solve them. For instance, how do we have the sensations of sight or sound? Of course I know what they say—that there is a small point in the body of some animal in the first instance that is more sensitive to light or sound than any other part; that this gradually becomes more and more sensitive in the course of generations, until at that point an eye or an ear is formed. If any man is able to believe that an eye or an ear is formed after this manner—that by the action of light upon a piece of organic matter an eye has been produced, or that the waves of sound have been able to produce an ear, I do not envy him his credulity. Much less if he is able to believe, even

[1] Cuvier's *Discourse on the Revolutions of the Surface of the Globe, and the Changes thereby produced in the Animal Kingdom*, p. 72.

when you take millions of ages into account, that by such a process such an intricate organ as the human eye or ear, with all its arrangements of adaptation to the work that God designs it to perform—and double, two ears and two eyes—should be formed! Helmholtz has said, very boldly and rashly, that if any optician gave him such an imperfect instrument as the human eye, he would return it on his hands. But he confesses, at the same time, that for its purposes it is a perfect instrument! If it had been made as his optician would make it, it would be more perfect, but it would be unfit for the purpose God designed it to serve!

I do not go any further into this question, because I believe it is best to confine your attention simply to outstanding facts. I have done so throughout these lectures. I have not cared to go into details, not because I am unfamiliar with them. It is more than twenty years since I began to study this question of evolution. At first, like many others, I was very much inclined to accept it. And the first thing that startled me, and made me begin to examine it again, was the perusal of Mr. Darwin's book. The very thing that determined the belief of some others determined my unbelief. Now Mr. Darwin is thoroughly fair, and the statements in his book disillusionised my mind. When he makes statements that do not bear out his claims, he tells you they do not bear them out.

No one in the whole world of science is fairer in that respect than Mr. Darwin. But when he comes to his conclusions, and works these out, he insists on these conclusions, though they are determined by facts concerning the conclusiveness of which he warned you all along!

Permit me to say a few words in regard to the origin of man. We have to go to the record in order to find information in regard to this. We have a certain amount of historical information bearing upon the past circumstances of man. Cuvier examined the representations dating back a few thousand years that are found in Egypt. He recognised no evidence of change from that time to this. He perceived marked characteristics of different races pourtrayed then as they now exist. He found, consequently, in this monumental record that there had been no change in the human race during a certain definite time. I am not going fully into the question—it does not lie in my way—as to the unity of the human race, although most scientific men are inclined to admit it now-a-days. Agassiz believed that there were several distinct pairs, yet all the different races of men are mutually fertile. You cannot cross different species without having infertility, but there is no infertility resulting from the mixture of different races of men, which is a very striking proof, if it be accepted in its full significance, that the race is really one. Then we have the impor-

tant evidence from language that Max Müller has wrought out. He has shown by his investigations that there are only three distinct languages—the Aryan, the Semitic, and the Turanian. And he hints that their structure may be found by-and-by to be one. But at all events there are these three classes, and it is well known that we sitting here are sprung from ancestors who came from somewhere in Western Asia a good many years ago. The Indo-European races spread from the western parts of Asia, some coming in this direction, and others going eastward and southward into other parts of Asia. We can prove that by the language; we have the same words in regard to the original home ideas, with slight changes, in all the different languages which all these different nations speak. Then we have a unity of tradition. There is the tradition about a deluge, for instance having happened long ago, and certain individuals being saved from that deluge in a particular manner. It is quite reasonable to think that there is a unity somewhere far back if you carry out the suggestions supplied by the existence of the same traditions and the same forms of language among different nations. So far as we can carry ourselves back by the historical record, we find that man has been always as he now exists. Many writers in the present day point to savage men and say that we are to look there for our ancestry. I am inclined to agree with

them very much if they won't go too far back. I am inclined to believe that the first man was perfect, but the *second* man was very far from being perfect, and might very well be the ancestor of a great many savages. Savagery came in very early indeed. And looking simply at the Bible as a historical record—I have given you reason for believing that it is one worthy of the fullest study and consideration—we find that the descendants of Cain began to build cities in different directions, but at the same time they were very cruel and very hard. There is no parallel relation, as though they were invariably associated together, between goodness of heart and cleverness of mind. These men were smart enough, as we would say, many of them, but they were intensely cruel and selfish. The consequence would be that the weaker, to use Mr. Darwin's expression, would be driven to the wall; that those who were of no use, or had no one to care for them and protect them, would be obliged to go further afield, seeking a home for themselves, until they would be scattered over the whole earth, not from choice, but from necessity. That is the natural progress of the human race since the fall, since the introduction of sin and the development of it in the world. Who could believe, for instance, that such a creature as man, helpless as he is, could be born in such a land as Tierra del Fuego, the most inhospitable of all countries, with blinding sleet and

piercing wind and exposure of the most dreadful kind? Man could not originate there, but man is found there. I mean, man could not spring up in his helpless condition and find the conditions of life sufficient for his existence there. But man is found there because he has been driven there, driven backward by the stronger, so that he had to take refuge on these shores. So we find throughout the world that the weaker races of man have been driven further and further afield, and the very fact of their being so weak, and allowing themselves to be thus driven, would lead to their weakness and barbarism being developed. You can find an explanation there, I venture to say, for the barbarism and savagery that we find at the extremities of the earth, in contrast with the civilisation and skill that we find in the nations dwelling on the banks of the Euphrates, the Tigris, and the Nile—civilisation that has spread westward to Greece, Rome, and Britain. I do not know how you can account for savagery in any other manner than that. It seems to me that is sufficient cause, quite in accordance with what we read in the Book, and what we might expect from the narrative we have there.[1]

As to there being any transition of man upward from a lower form, we find no proof whatever. Of course it is easy to say that the ancestor of man was

[1] Of course this would apply, *mutatis mutandis*, to the peopling of the world after the deluge.

"a hairy quadruped, furnished with a tail and pointed ears, probably arboreal in its habits, and an inhabitant of the old world." That is what Mr. Darwin says. But there is no proof. The monkeys are like us in many respects, but very unlike us in others. And those that are likest us in their material form are the most unlike us in other qualities. The truth is, Mr. Darwin admits *that none of the present monkeys could be our ancestors. He supposes our ancestor was an extinct* monkey, of which there is no specimen existing in the whole world, either in a fossil or in a living state! I do not think that I am exaggerating in the slightest degree. He postulates this probable ancestry from the necessity of the case: because we must not only have the form of the monkey developed, but also certain other qualities that do not exist in such near cousins as the gorilla and the chimpanzee. These, while in their anatomical and physiological structure they have certain relationships to us, are a whole world apart from us in other important respects. Professor Huxley, who endeavours to show in his book on *Man's Place in Nature*, that at least some monkeys are very closely allied to us in physiological characteristics and anatomical structure, says that when we come to the consideration of mental qualities, there is an immense distinction between a man and a monkey.[1] And I

[1] "No one is more strongly convinced than I am of the vastness of the gulf between civilised man and the brutes; or is more certain

apprehend that this is an important element in the case, and the element of all others that we have to emphasise in connection with this theory, of the development of man from the highest of the brute creation. I do not consider the monkey by any means the highest. Elephants are a great deal wiser, and dogs are a great deal more humane. You can find monkeys that may be trained to perform certain actions, but these are least like us materially. The gorilla is one of the most unteachable of the whole class. There are monkeys brought from America—they are new world monkeys, not our ancestors—that can be taught some tricks, and are so taught by itinerant Italians. But these are not in our line of descent, and we are not to be credited with any of their cleverness. If you are to have man, you must not only have the external form of the monkey, but the constructiveness of the beaver, the frugality of the bee, the articulation of the parrot, and a great many other qualities gathered from the whole animal creation, and MIND to crown all.

Just think of what man is. Mr. Alfred Wallace has written a book on *Natural Selection*, that is intensely interesting; and I venture to say, like Mr. Darwin's, valuable, notwithstanding the peculiar theory which he advances in it. He is considered by some as

that, whether *from* them or not, he is assuredly not *of* them."—*Huxley's Man's Place in Nature*, p. 110. It ought to be added that Professor Huxley recognises speech as the distinctive faculty that elevates man. See *Lectures on Organic Nature*, p. 55.

entitled to rank at least alongside of Mr. Darwin, in so far as the discovery of this mode of descent is concerned. He says that when he comes to consider man the theory of natural selection breaks down; that it is impossible to explain the position of man and the nature of man, on the theory of natural selection alone. He must have been framed definitely by wisdom, and with a purpose. And he calls attention to some facts that are of weight in the controversy. Take two facts. One is in regard to his physical conformation. He calls attention to the fact that he has no fur or hair; at least none such as his friends the monkeys and other animals have. Monkeys have a definite hairy covering all over them; we have not. Now you remember natural selection proceeds on this line: it cuts off the weak and preserves the strong. And consequently where there is any element likely to be useful in the struggle for life, that element is preserved. The possessor has an advantage which gives him precedence of all others, and those who have better qualities for succeeding in life exist, while the others go to the wall. Would it be any advantage to the monkey to lose his hair, and to become naked as we are? Would it help him to live longer, or be more conducive to his health, to be thus exposed to the changes of climate, than to have his own natural clothing? You must remember that savage man does not make clothes such as we wear. He tries to cover

himself in different ways, but it is a great *disadvantage* to savage man that he has no fur like the bear or hair like the monkey. How did he come to lose it? Darwin has devised a new theory to fill up the gaps in his former one. He suggests that it has been done by *sexual selection.* The ladies preferred the hairless to the hairy! In that way the line of descent gradually stripped off the covering! That really is the explanation. To my mind it seems somewhat ludicrous, as it does to yours. And I cannot help asking, if such ideas were brought forward in connection with other subjects with which we are familiar, would we not be laughed at immoderately because of our foolishness? But scientists apparently say a great many things that are jocular, in earnest. One very wise naturalist has suggested that this want of hair might have originated by our savage intermediate, during the transitional stage, finding his own hair was not warm enough, wearing on his back the furs of other animals, which gradually wore off his own hair! I do not think Mr. Darwin adopts this, although he alludes to it. But the unfortunate thing is that we do not transmit such peculiarities to our offspring. The Chinese have been for a long time attempting to make the ladies' feet small, but unfortunately the little girls are born with big feet, as though their mother's feet had never been cramped at all. The process has to be begun over again in each generation. We do not find

in nature that there is a transmission in this way, even if such a result could be once secured. And certainly hairlessness or furlessness is a disadvantage in the struggle for life.

Then, again, Mr. Wallace points to this fact. The relation between the brain development of monkeys on the one hand, and savages and civilised man on the other is in this ratio. Take monkeys, and you have a cranial capacity of ten; in savages it is twenty-six; the highest civilised man has only a cranial capacity of thirty-two. Six is the difference between the lowest savage and the highest man; sixteen is the difference between the monkey and the lowest savage. Not only is there a great gap here for which we have no bridge, but there is this other circumstance. How does it come about that savages have so much more brain power than they ever use? Mr. Darwin tells us that he was much surprised to find that some savage men, brought from Tierra del Fuego to England, two or three years before, were in no respect very different from Europeans.[1] We know that savages, in the course of one or two generations, are thoroughly educable; they can be trained just as readily as our children can be trained. You cannot do that with a monkey. But you have in savages a certain content and capacity of brain that only requires to be exercised to have them stand on a level with any of us. How

[1] Darwin's *Voyage of a Naturalist.*

does that come about? Natural selection could not give it. It only gives by small degrees as is required in the struggle of life to make some better than others. But here is a great leap, between ten and twenty-six, and that sixteen almost all unused. I do not suppose Mr. Wallace would accept this explanation, but I venture to suggest that they have become degraded from a higher condition. Their ancestors, who had full brains, knew how to use them, but by subsequent disuse the power or capacity to employ them has disappeared, though, because the brain remains the power can be regained. Time warns me that I must conclude. I would just recall your attention to these facts. There is no bridge between the living and the non-living. Science knows of none. Science knows of no bridge between one species and another. Science knows of no bridge between the brute and the man. I confess that if there were a bridge between the living and the non-living, between one species and another, and between the brute and the man, and that such bridge was formed by Divine operation according to ordinary laws, it would not shake my faith. I do not reject evolution because I believe in the Bible. I was quite prepared to accept evolution if it could be proved to be true, along with the Bible—of course I would say, through the working of God according to the counsel of His own eternal will. I reject it *in hoc statu*, simply because the facts of nature are against it.

VI.

THE NATURAL HISTORY OF LIFE.

LORD BACON, in his discussion of the fables of the ancients, adverts to the legend of Proteus. This individual, according to mythical writers, occupied the responsible post of Neptune's herdsman. He was accustomed to count over his flock of sea-calves every day at noon, and so soon as he had performed his task he went to sleep. It is said of him that he was thoroughly acquainted with things past, present, and future. Many had recourse to him that they might gain information from his wisdom. But when they attempted to question him, they found that they could only get an answer by binding him hand and foot. And in the process of binding he contrived to assume a great many different shapes, sometimes appearing as water, sometimes as fire, and sometimes as a wild beast, so that it was not an easy thing to get him bound down, or to compel him to answer such questions as they had to put. Lord Bacon thinks that Proteus represented matter, and that, as the ancients believed all matter sprang from a fluid condition, it was aptly set forth as occupying

this position of herdsman to Neptune, the god of the waters. And as matter also takes many forms, and, in order to be questioned, requires to be straitly confined, so he thought the ancients represented the difficulty of putting questions to nature under the fable of Proteus.

Now I am quite sure of this, that life is Protean in its action, and more than Protean in its mysteriousness and elusiveness. We can describe its characteristics as they are presented to us in different objects without much difficulty. We can trace its manifestations within certain limits. But its nature—its ultimate—we cannot find out. And if you have followed the statements I have hitherto made, you will quite readily understand that I have not been endeavouring to adduce any new theory of life, or explain, after a novel fashion, the difficulties encountered in the study of it. My object has been to consider certain theories that are now commonly suggested, and to give reasons that, to my mind, are substantial, why I am not prepared to accept them at this stage of our knowledge. The question in regard to this thing "life," is not whether it may not be manifested in this form or in that, but whether we can explain it definitely and altogether, in terms of matter, or of material existence. Attempts have been made to explain all that transpires in the plane of animal life in terms of material existence and law. And all I

have been endeavouring to prove is that such attempts have hitherto been only failures. We have not yet examined the higher plane of intelligence. When we come to that we find that even those who are most anxious to explain, in material terms, the actions of life, confess their inability to use these terms in speaking of thought, and emotion, and will.

The truth is, as is universally admitted, we find different planes of existence within the region of matter itself. We have, first of all, elementary matter —matter in the common form of such elements as hydrogen, oxygen, phosphorus, and iron. Then we have matter existing in combination, such forms, for instance, as water—a compound of hydrogen and oxygen; or as sulphate of lime—a compound of hydrogen, oxygen, and calcium. Then we have the higher plane of vegetable life in which we find matter occupying another position, and manifesting other properties. We find a higher plane still in animal life, in which matter is directed to new ends, and to the performance of new functions. I am speaking only of matter. I do not mean to say that there is only matter in animal life, but I am speaking of the manifestations of matter as we find it in these different planes. Now I think it is too much to say that matter, in the elementary form, is entirely equivalent to matter as we find it in chemical combinations. We have to do then with force, and I am not sure that we

know much about that. Force acts according to certain laws; it is somehow controlled by certain definite rules which it always follows; but these it would puzzle even the most intelligent chemist to explain. We are told, for instance, that one element chooses certain elements in preference to others, and enters into combinations with them, refusing ordinarily to enter into similar combinations with the others; that one element leaves those with which it is found in combination when another is present for which it has, if we may use common language, a stronger liking. There are difficulties when we attempt to explain these laws of chemical combination, in regard to their ultimate meaning, that have not yet been met.

When we come to vegetable life, and most of all, to animal life, and examine the actions of matter under these new forms, we find that the difficulties become vastly greater,—the problem becomes progressively more perplexing and more difficult of solution. It is very easy to do, as some have done, to make a child's puzzle for ourselves, then cut it into pieces, and afterwards, knowing the whole arrangement, put it together again in its original form. I venture to say that *that* very much corresponds to what has been done by certain philosophers in their endeavours to account for the whole of material existence, and mental existence as well, by this theory of evolution.

Instead of giving us a solution of the problem, they dissect a puzzle that they themselves have constructed, and then rearrange it, knowing well what its original structure was. But there is nothing very ingenious in that performance. Mr. Martineau[1] pointed out this fact in one of the answers he wrote to certain statements made by Mr. Herbert Spencer. He averred that if it were true that this law of evolution is the construction of the compound from the simple, then we have in the original matter, from which the whole existing world was formed, all the potentialities and possibilities afterwards manifested.[2] Mr. Spencer replied, "That is quite true. And you will find, in the second edition of my *First Principles*, that I have made the admission, and that *Involution* would be the better term to express the doctrine we teach than *Evolution*." That is to say, all these things that come out of the original substance were, somehow or other, involved in it from the beginning. Well, if that be the real answer, and if we take it as an explanation of the whole process that is afterwards so fully carried out in this evolutionary philosophy, it does not seem to touch in the least the design argument. Nor does it answer, in the slightest degree, some of the questions that arise in regard to the whole subject.

[1] Martineau's *Place of Mind in Nature and Intention in Man.*

[2] "What is the seed but a casket of pre-arranged futurities, with its whole contents *prospective*, settled to be what they are by reference to ends still in the distance?"

We have simply a gradual development of what was at first enwrapped or included in primal matter. But we ask ourselves, Whence came that primal matter? How did it happen to have all these possibilities contained in it? Who gave it this existence? Who endowed it with these properties? We have not got one whit nearer a solution of the problem of the world or of life than we were before. We are merely told that there was a germ—an immense germ—a scattered germ if you will, but still a germ; and that this, in the process of time, according to the laws of its development, has given to us the world as it now exists. If Involution be the doctrine rather than Evolution, it does not at all occupy the position that it seemed to have occupied when it was first started, and when it startled men by its novelty and its surprising statements.

Without proceeding further in that direction, I have to speak to-night of the natural history of life. At our last meeting I stated that I accepted fully the argument adduced in connection with the imperfection of the geological record, and I could not insist, with any fairness, on the geological record as giving us a complete or satisfactory history of life. Still we may gain certain information, certain facts, from the study of the geological record, to which we may attach a due amount of weight. Speaking then broadly, and with this admission, I think we learn from the

geological record that progress has been made from the less special to the more special, or from the general to the particular in the development of organisms. Only this has to be taken with a certain large qualification. Still, speaking broadly, it may be admitted freely enough, on the whole, that there has been an advance, so far as we can trace it. You must remember, however, along with that, that there have been sudden appearances of specific forms of life, and as sudden disappearances of certain forms of specific life. We have no ancestors in the one case, and no descendants in the other case. There are absolute breaks, that we find it impossible to fill up, between classes of animals that have existed at one time, and those that went before, and also those that followed after. There have been distinct separate species, appearing at certain intervals on the earth, and vanishing away without leaving any trace of any succession behind. I do not think it is possible to explain that feasibly in connection with the theory of Darwinian descent, or in connection with the theory of evolution.

Then we have also this fact that has been adverted to somewhat frequently of late, that the lower forms of life, the very simple organisms, have a capability of development, admitted on all hands. Their material is supposed to be plastic in proportion to its simplicity. From these lower forms higher and higher forms are

supposed to have sprung in genetic succession. What I want you to note is this, that a great many of these forms exist still. And the question comes to be, How is it that there has been development, according to the theory, from these forms in a hundred instances, and no development in a hundred instances remaining? How is it that the struggle for life—the survival of the fittest—is supposed to land certain forms in the high condition in which they are found to-day, according to the teaching of evolution, while other forms have remained in their original state, and have made no upward progress whatever? We find, now-a-days, that certain animals, and even certain plants, when they are translated to other regions—for instance, European plants or animals translated, say, to New Zealand, or some parts of America—take the place of indigenous animals and plants, and drive them out. It may not be quite possible to explain how this happens, but we know it does happen, and we ask the question in regard to these advanced and improved forms, How were they unable to starve out or drive out lesser forms that remain in their present condition? There is no evidence of "the survival of the fittest," for we find the survival of the unfit as well as of the fit. We do not deny that there is progress in the plan of creation, but we cannot find out, I believe, or give any reasons why creation should have taken the plan that is submitted to our investigation.

rather than any other. I think he would be a bold man who would presume to explain the reasons that may have guided Infinite Wisdom in the arrangement of this world and the creatures that inhabit it according to present facts. But while we do not attempt to make any such explanation, while we do not profess to be able to solve that question, we admit that there has been a definite progress from the lower to the higher, during the period of, shall we say, development. That God—if you will allow us to use that word here, in speaking of this matter, and while we are merely dealing with scientific facts—that God created according to plans and ideas in His own mind—if we may use human language in speaking of Him—different creatures for wise purposes, and that these have certain relations the one to the other, is apparent to the student of nature. The thing to be proved, in order that the natural history of life, as stated by evolutionists, may be established, is that these different forms of life sprang genetically the one from the other. We have no contention in regard to the different forms, or in regard to the progress of the forms, or in regard to the fact that there are lower and higher, or that the lower and higher have occurred, if you like, in definite order. But we ask proof that the higher sprang from the lower, directly, by genetic succession, that the lower was developed, after this fashion, into the higher form in successive time. And

for that no evidence whatever is produced. So that we are not driven into a corner, or are in any difficulty, when we freely admit that there are gradations of development, as well as types of development; in the whole field of nature we find that a wonderful variety is undoubtedly existing all around us.

When we come to the natural history of life, as it is manifested around us, we find, as I have explained on former occasions, that all life springs from a germ—the life of man no less than that of the vegetable. And I would call your attention to this curious fact, that I have not yet noted, in the case of vegetables. Take the case of a tree springing from a seed, or a grain of wheat put into the ground, and producing ultimately stem, leaves, and fruits. We have in the small germ a supply of nutriment laid ready for the germ, on which it feeds until it gets into the sunlight and the air and is able to carry on its own functions. I wonder that no one has started this theory, that there is evidence in this, that plants are degenerate animals. For it is one of the marked characteristics of animal life to live on organic matter. A great deal has been made of embryonic development by our Darwinian friends. Because the human ovum passes through certain stages that correspond with reptiles, fishes, &c., before it reaches the full perfected form of a human being; they say this indicates that there must be a genetic connection between it and these

other forms—the fish and the reptile forms. Very well, here we have plants beginning after the fashion of animal life; instead of feeding, as they do, afterwards on inorganic materials, with certain exceptions adverted to formerly, they begin by feeding on the organic material laid up in this storehouse. I do not make any point of that. I am merely calling your attention to it as a fact that might be used by some very ingenious person as an illustration of the degeneracy of animals into plants.

Then if we take the tree, with its stem growing and continuing to grow for a great many years—some trees, like the oak, have been known to attain the age of 1,500 years, and other trees, like the yew, have been known to attain double that age, more than 3,000 years—it has been suggested by Schleiden [1] and others, that really these are not units, but a mass of individuals,—that they are just like other plants—annual instead of perennial. That, in fact, the leaves are the living parts, and the stem is dead. The only difference between them and other plants that spring up and wither in the course of a single year, is to be found in this, that they have connection with the stem that is rooted in the ground, and other plants have their own connection directly with the soil. That may be true or it may not, but certainly, when we come to such a being as man, we find that it does not

[1] Schleiden's *Principles of Scientific Botany*, p. 538.

hold good. Although it is true, as has been pointed out, that all the different parts of our body have their separate life—there is not a single cell in the body that has not its own life and that does not perform its own particular work—in addition to this, that we may call the molecular life of the body, there is a unity given to the body somehow and somewhere. There is also the unity that mind or thought gives. How is it that I know I am the same individual to-day that I was twenty or thirty years ago? Physiologists will tell me that my body has changed several times during that period. All the particles of the body have been removed once and again, and new particles supplied. How is it, notwithstanding this continual change, a change that is taking place day by day, and steadily through all the years I have lived, that I still maintain my consciousness of personal identity? Some philosophers suggest that these different molecules in the body are like sentinels. The one is displaced by another, and the new comer has the word given to him as he arrives, so that there is a maintenance of the identity notwithstanding these continual changes. That may be poetry, but it is not science; it does not make the matter one whit clearer. I am not brought in the slightest degree nearer a solution of the mystery by this poetical representation of what may be supposed to take place. But if I recognise that there is in me something apart from the matter, something

changeless in addition to the changing, a mind that is allied to the matter and yet distinct from it, and that is altogether and always maintaining its own definite character, amid all the surrounding transmutations, then I have a valid explanation and a satisfactory explanation given of this personal identity.

There is a story told of a student in the Aberdeen University, who was listening to the lectures by his professor on this subject of personal identity. Thinking to put a puzzling question to the professor, he said, "Suppose I had a knife and lost the blade of it; if I got a new blade added to the handle, would it still be the same knife?" Of course he had been learning about the changes in the body—how it was changing all the time, but the individual remained. "Yes," said the professor. "Then, supposing I lost the handle, and got another handle, would the knife still be the same?" With some hesitancy the professor answered, "Yes." "Then, if somebody found the old blade and the old handle, and put them together, what knife would that be?"

Our bodies are necessarily changing, and yet we remain consciously the same. The materials of my body may enter into a thousand other forms in the process of time; and yet I, the individual, am not affected by those changes, because there is something other than the body that has a definite existence, and that somehow does not undergo that change. I suppose

a man of about 140 pounds weight passes through his body more than a ton of material in the course of a year. This is certainly a large amount, and yet with all that continual change—because our bodies are never resting, never in one settled state at any time together —yet with all that change we maintain our identity unaltered.

How is it? There are a great many questions that suggest themselves to one's mind in regard to the subject. With all this change we not only maintain our consciousness of personal identity, but have all the experience of the past recorded and ready for use. I do not think it is possible to explain this on the theory of materialism. We are obliged, as the simplest explanation, and the only one available in the circumstances, to accept the fact that there is something in our bodies besides matter that we call *mind.* When we have a better name for it suggested by any one, it will be time enough to think of changing our nomenclature.

Indeed, Professor Tyndall himself admits, without any hesitation, that it is impossible to pass from matter to consciousness; that there is a gulf between these two things that we cannot bridge over. I have brought the second volume of *Fragments of Science*—the new edition recently published—because I desire to read to you this extract, which is sufficiently suggestive as coming from Professor Tyndall;—

"Were our minds and senses so expanded, strengthened, and illuminated, as to enable us to see and feel the very molecules of the brain; were we capable of following all their motions, all their groupings, all their electric discharges, if such there be; and were we intimately acquainted with the corresponding state of thought and feeling, we should be as far as ever from the solution of the problem, 'How are these physical processes connected with the facts of consciousness?' The chasm between the two classes of phenomena would still remain intellectually impassable. Let the consciousness of love, for example, be associated with a right-handed spiral motion of the molecules of the brain, and the consciousness of hate with a left-handed spiral motion, we should then know when we love, that the motion is in one direction; and when we hate, that the motion is in another; but the WHY would remain as unanswerable as before. In affirming that the growth of the body is mechanical, and that thought, as exercised by us, has its correlative in the physics of the brain, I think the position of the 'materialist' is stated, as far as that position is a tenable one."

We do not doubt that. As long as we are in the body we are limited by matter; necessarily connected with this world by such chains as matter binds around us; and that, to a very large extent indeed, our thinking and feeling are affected by this state in which we

find ourselves placed, no one would feel disposed to deny. The Professor goes on to say:—

"I think the materialist will be able finally to maintain this position against all attacks; but I do not think, in the present position of the human mind, that he can pass beyond this position. I do not think he is entitled to say that his molecular groupings and motions, explain everything. *In reality they explain nothing.* The utmost he can affirm is the association of two classes of phenomena, of whose real bond of union he is in absolute ignorance. The problem of the connection of body and soul is as insoluble, in its modern form, as it was in the pre-scientific ages. Phosphorus is known to enter into the compostion of the human brain, and a trenchant German writer has exclaimed, 'Ohne phosphor, kein Gedanke!'[1] That may, or may not be the case; but even if we knew it to be the case, the knowledge would not lighten our darkness. On both sides of the zone here assigned to the materialist he is equally helpless. If you ask him, Whence is this 'matter' of which we have been discoursing; who or what divided it into molecules; who or what impressed upon them this necessity of running into organic forms? he has no answer. Science is mute in reply to these questions. But if the materialist is confounded, and science rendered dumb, who else is prepared with a solution?

[1] "Without phosphorus no thought."

To whom has this arm of the Lord been revealed? Let us lower our heads, and acknowledge our ignorance, priest and philosopher, one and all."

Not so, Professor Tyndall; the arm of the Lord has been *revealed*, and we can prove, on sufficient grounds, the *revelation* of this arm of the Lord. But that is not my purpose to-night; I am simply dealing with this subject as a question of science. And I take this remarkable admission as a thorough affirmation of what I have been endeavouring to show in regard to life, especially this higher form of life of which we, as thinking men, are conscious. Science has nothing to say about it, and science, therefore, ought to be dumb. When we come to ultimate facts in connection with these matters, beyond which we cannot go, to adduce any theory or device in the form of a hypothesis, not to explain, but to use as an argument against other truths, say in the theological sphere, is a device unworthy of intelligent men. And I do not know more frequent methods employed, in these latter times, for arguing against the truth that we receive as Christians, than devices of this kind. Again and again it has been stated; no one can read the books on the subject without having it flaunted before him that Evolution and Darwinism have destroyed the design argument. It was all very well for Paley to write his treatises, and for those who lived before Mr. Darwin to say that we have evidences

of creative working. But since this evolution doctrine has been divulged, we must give up all these attempts to establish the interference or action of a Divine Being. Nature is quite sufficient to explain its own processes if we only watch them.

My answer is simply this: You have not proved your doctrine of evolution. And until proof is forthcoming, we decline to accept evolution as a refutation of design. I think it very unfair to bring forward a theory that breaks down at all its stages as a refutation of a belief that we have on very good grounds accepted in the present, and that our forefathers have accepted in the past. Sir William Thomson has stated his belief that, instead of the design argument being weakened by recent discoveries, it is made stronger by all that we know. And Sir James Paget,[1] calls attention to the fact that in the animal there is provision made, not merely for the natural processes of life, but for the repair of injuries that are only possible or accidental. He recognises the wise design of the Creator who has made this extraordinary provision for the extraordinary and for that which may never happen. We have evidences of design all around us, and nowhere more markedly than in the natural history and development of life.

There is one point to which, perhaps, I ought to advert, in connection with the natural history of life,

[1] Paget's *Lectures on Surgical Pathology* (edition, 1863), p. 114.

namely, the *duration* of life. Why is it that the rabbit lives eight years, and the dog twenty-four years, and that men and women live so many more years than these and other animals? What determines the difference between the longevity in the one case and the shorter term in the other? No one can give any answer to the question other than this: that to each seed has been given, not only its own body, but its own duration in time. It has been brought out very fully by Flourens, a French writer, that there is a relation between the *time when maturity is reached* and the term of life. He takes as his test the maturation of the bones, and he finds, for instance, that in a human being the bones are perfected about the age of twenty. Taking five as the multiple which he finds to apply *in all the cases he has examined*, he takes the natural duration of human life to be five times twenty, or a hundred years. Of course our medical investigators are asking our attention to this fact, that human life ought to extend to a much greater duration than it does; if we were surrounded by different circumstances, and if we were wiser and more careful, our lives would be greatly lengthened out. And there can be no doubt of the truth of their teaching. It is a fact we should not ignore, and it ought to make us thankful to the very able and wise men who have laboured so patiently in this direction, especially within recent years. The duration-term of human life is expanding; the average of life is grow-

ing larger and larger as time goes on. And if the sanitary measures being devised so carefully by our medical friends are given force to, as they ought to be, by those who have political power, I have no doubt whatever that human life in our own country will be increasingly extended.

I am adverting, however, to this point, not to speak of these things, but to call your attention to the fact that certain writers—Professor Owen, I think, among the number, in an article written some time ago in *Fraser's Magazine*—are endeavouring on this ground to discredit the Biblical statement as to the long lives of the patriarchs before the Flood. They assert that it is quite impossible that anyone, constituted as men are, should have lived 900 years. Now, of course, if we take development as giving us the unit, and multiply that, in order to ascertain the duration of life, then it does seem an impossible thing that man in any circumstances should attain to the age of 200, 300, 500, or 900 years. But there are a great many instances on record in which men have attained more than a century; some have attained to as much as a century and a half. It may be that exceptional circumstances will account for them, but the *possibility* of them ought to be taken into account. Besides, we are ignorant of the circumstances in which these patriarchs lived before the Flood, and there are indications enough given in the Book that contains their lives that the circumstances of existence were different

then from what they have been since. But I would not meet the statement on either of these grounds. I would meet it on much narrower and simpler ground than those suggested. Why is it, or whence is it, that Flourens comes to this conclusion that the term of life is to the development as five to one? Because he has examined a great many cases and finds that that rule applies. I would ask this question: Suppose we discovered animals whose term of development was, say five years, and whose term of life was a hundred, would we not accept the fact and write it down as exceptional? Because, even if we could not give any explanation of the exception, if we discovered such a fact, the very existence of that fact would be sufficient to secure its acceptance. We would be obliged to allow it to stand alongside of the other general statement, although it was not quite in accord with the other cases. If we find that, before the Flood, men are narrated to have lived to the extent of 900 years, the question simply is, what proof have we that it is a correct statement? There is nothing in it to make it scientifically impossible; it would simply be one of the factors which a fair induction would include, just as there would be nothing unscientific in a discovery that some other animals had a different duration, measured by another rule.[1] We

[1] Besides, we know nothing of the development-term of the Antediluvians. The unit may have been, as some have supposed, a hundred instead of twenty.

would simply ask, What is the evidence on which it rests? It may raise the question as to the exactness of the record, and it may raise this other question that has been raised, whether we are right in reading these years as years of 365 days. I accept them myself as years of 365 days; I see no reason for doing otherwise. It may raise the other question whether these are the names of individuals or the names of races. I do not see any reason for raising these questions. I have a very strong feeling, and it grows stronger day by day, that we ought to make no such admissions, that we should be very unwilling to make any admissions of any such kind that are not absolutely forced upon us by the necessities of the case. It is a very weak policy to be always making admissions, and seeking to explain away what we imagine to be difficulties, as if they were insurmountable. I do not know of any such difficulties. This one, as I have explained, is not insurmountable. It is simply a question of fact. When Cuvier was examining certain fossil remains found in a quarry at Montmartre, he came to the conclusion that the mammoths, the remains of which he discovered, existed long before man. His ground for making this affirmation was, that he found no human remains along with these other remains. Therefore, he held, the mammoths must have been very ancient because they were anterior to man. But, by-and-by, in the

course of years, some indefatigable geologist found human remains, or relics of humanity at least, existing along with the remains of the mammoths, and what was his natural, irresistible conclusion? That man must be *very ancient too!* The mammoths were counted very ancient because they existed without any human remains. Now that we find human remains existing along with them, man must be relegated to a far distant date, long before Adam, because of his existence along with the mammoths! Such reasoning—and unfortunately it has been too frequent—is not valid when fairly looked at. But very much of the reasoning that we have to contend with is of the same character. The only admissible objection is the impossibility of such duration, founded not upon such partial observation, but upon some definite physiological law. Flourens founded his conclusions only on observation. He studied the life-history of many animals, and found that their term of life, in proportion to maturation, was five to one. By an induction he came to the conclusion that that was the term of life applicable to all, that it might be assumed to extend indefinitely, backward and forward. But if there be proof forthcoming that there are other cases in which the duration is not five to one, that is a new fact to be taken into account in forming a conclusion, or modifying a conclusion already formed. Or if the human race at any other

period had a much longer period of maturation than twenty years, that, of course, changes the calculation. In any case it is simply a question of evidence, to which only the ordinary laws of evidence are applicable.

VII.

ENEMIES OF LIFE.

STANDING in the centre of the square at Brussels where the statues of Counts Egmont and Horn are placed, one reads a Latin inscription on the house behind them to this effect: "From pestilence, famine, and war . . . deliver us."[1] We may take these three as the typical Enemies of Life.

And we may, not unfitly, at this stage raise the question whether we are warranted in offering petitions to our Father in heaven for deliverance from these great evils. Unquestionably we are. There is no matter that affects our interest, no burden that we feel resting upon us, concerning which we may not pray to Him who heareth prayer. Let us never forget that while second causes may be distinctly enough noted, and while we may have sufficient competence within the sphere of their operation, yet God is the First Cause, and "power belongeth unto God." And there is no inconsistency when we use our most skilful endeavours to remove the cause of the very various evils that we can recognise on earth, and at the same

[1] *A peste, fame, et bello, libera nos, Maria pacis.*

time plead before the heavenly throne for God's blessing. Indeed, if I read my Bible rightly, I find that God instructed men very early how they might avoid most effectively these three great evils. We all remember how Joseph was instructed, for instance, to prepare for the years of famine during the years of plenty. We have also read the lessons of prudence which God gave to the people that He had separated. In the agricultural rules He laid down for their direction, He gave them the best security against years of want. And who does not know that in forbidding them to multiply horses, and in making them an essentially peaceful people, He took the best means for guarding them against war. They had certain battles to fight until they took possession of the land, and they found that God was the God of battles too. But when they settled down in the land, it was His design—and if they had followed out that distinctly they would have enjoyed His blessing more fully than they did—that they should be free from that second great evil. And no one can read the institutions of Moses without recognising the wise sanitary regulations—regulations followed out to some extent by the Jews to this day, giving them consequently more than normal healthiness among the peoples of Europe, notwithstanding many drawbacks in their circumstances[1] —without perceiving that God

[1] See a very interesting account of "Jewish Vitality" in Dr. Richardson's *Health and Life*, p. 16.

supplied the instructions and precautions needful for averting pestilence. God *may* answer prayer in these matters by giving us wisdom, fidelity, and faithfulness in the execution of such duties as we recognise from the study of these laws and the consequences of our breach of them, as well as by direct intervention in the removal of some specific cause or some threatened form of danger. We may have God's help in warring successfully against these enemies of life by the measures that He Himself teaches us, by common sense as well as by our science, to use.

I remember distinctly, more than a dozen years ago, being in Antwerp during a very severe visitation of cholera. The hospitals were crowded, and there were few houses in which some did not suffer from that plague. I remember seeing the priests going round the streets of the city in procession, carrying various charms that they thought likely to remove this dire visitation. I need not tell you I had no sympathy with that specific endeavour to arrest the progress of the malady. I had far more faith in the sanitary efforts of the doctors than in any such methods. But at the same time I see no severance, no opposition of any kind whatever, between prayer and obedience Let there be obedience first, and then prayer. But prayer with disobedience and neglect of plain precautions that God teaches us to employ, both by our own judgment and by the knowledge that has been accu-

mulated by diligent study—disobedience of that kind, though accompanied with prayer, is an insult to God. We may not expect after such fashion to escape sufferings that are mainly due to our own folly and negligence. Let there be prayer and painstaking both together.

To a very great extent we carry the cure for these evils in our own hands. If the world were wise enough, if the people dwelling on this globe were prudent and thoughtful enough, we could put an end to war, famine, and pestilence to a very large extent indeed. "From whence come wars and fightings among you? Come they not of your own lusts which war in your members?" We gave a grand exhibition to the world of the true method of averting war in our settlement with the United States of the *Alabama* claims. I believe that it is by arbitration of like kind that we may hope that this martial scourge of mankind will be arrested. And that can only be attained by the progress of Christian sentiment and Christian love. It is just in proportion as we become truer and more loyal to the Lord Jesus Christ, that we shall exercise such an influence upon our governments as will make it impossible for them to break the peace. I am not going to say that there are no circumstances in which war may not be justified; but I do say this—and I say it without any reserve whatever—that in all cases where man is slain, there must be cause shown to

justify the homicide. Whether it be in masses or in separate individuals, murder is murder all the world over, and we are bound, if we have committed it, to produce the plain facts that have compelled us to do it, either for self-preservation or for the preservation of peace. That nation "which lets loose the dogs of war" assumes a very serious responsibility indeed.

Famines can be arrested to a very great extent now. We do not meet with such multitudes of deaths thus occurring as happened not very long ago, and more markedly centuries ago. Now, by the kindly interchange of courtesies that we call commerce, in which there is not merely kindness shown but real benefits gained and conferred by nations mutually, the want of one is supplied by the fulness of another. The supplies that we have sent to others are more than compensated for by the food that is brought to us from the far West or from the shores of the Black Sea. By means of these inter-relationships between the nations of the world, a year of plenty in one land is sufficient to meet the wants caused by a year of scarcity in another. There is such a variety in regard to springtime and harvest throughout the whole world that we find deficiency in one country is counterbalanced almost invariably by abundance in another. We can carry food from afar to those that lack, so that there may be no want throughout the world.

Then, in regard to pestilence, of which I have to

speak more particularly—whether in the more aggravated or less aggravated forms of disease—I believe we are now in a position, at all events, of knowing very fully the causes and of dealing effectively with them, if we are wise enough and bold enough to use the power we possess. And let me say, at this stage, that there is no class of men, I believe, in the community to whom we are more indebted in this respect than the medical men of our own country. When one of them was giving evidence before a committee, I think of the House of Commons, an eminent Queen's Counsel smiled at the answers he gave in connection with the improvement of the health of the community, and said, "It would be thought a very strange thing indeed if a Queen's Counsel made it the whole business of his life to devise means whereby people should be kept from going to law! And yet these doctors are devising means whereby people may be kept from suffering by disease." There has been much done in the past, and there is much more being done in the present. And if our Government is wise enough to avail itself of the skill that is so freely placed at its disposal, and of the results of science that have been already reached, I am quite confident a very marked improvement in the health of the people must follow within a very few years. Indeed, there is a marked improvement in many parts of the country already. There is a city, I know very well, that used to be notorious for its death-

rate. When the authorities secured sufficient powers they contrived to make streets through the most crowded parts; they introduced an abundant supply of pure water from a Highland loch, many miles away, and executed other sanitary improvements at enormous expense. The consequence was that they reduced the death-rate of the city, so that, instead of being one of the most unhealthy, it has come to be classed amongst the healthiest cities in Great Britain.[1] What has been done in Glasgow can be done throughout the length and breadth of the land. We have sufficient means at our command for promoting the health of the community. We know the fruitful causes of disease—such, at all events, as attack large masses of men and women—and we have it in our power to increase the healthful elements, and decrease, to an enormous extent, these causes or occasions of disease. And no government, I venture to say, can make a more real endeavour in the direction of benefiting the community than by attending to its sanitary well-being. I say that because I regard this as the foundation of a great many other things that in themselves are much more important than health. So long as we are in the flesh we are influenced more or less by the solid substance that we call our body. If that be diseased or injured organically or functionally, there is not merely

[1] In Glasgow, at the time when this lecture was delivered, the death-rate for the week was reported as seventeen in the thousand.

suffering in the physical organism, but there is dulness of mind, rashness and irritableness of temper, and a great many other evils, even overlapping the confines of morality. Bodily faults not unfrequently give rise to very unsocial evils and crimes that curse the whole community from the top to the bottom. If we could have the whole land clean—I mean physically—we would find that bodily cleanliness "to the mind lends a secret *sympathetic aid;" that there would be a general advance, corresponding to this improvement in the health* of the people. Nay, as respects the morals of the people also, we would have at least a foundation, firm and broad, on which to rear other reforms, enabling us to act more effectively and with more hopefulness, in our endeavours to reach the highest spiritual result.

Perhaps I am tempted to speak more strongly on this subject because my attention has been necessarily drawn to it during my years of medical study. But I am quite sure that the importance of having the bodies of the people in health—not merely living, but in healthy life—is almost incapable of being exaggerated. For it is not merely the waste of life that we have to look at. We have also to take into account lessened vitality and physical deterioration. Pestilence slays its thousands; sometimes in the past it has slain its millions. We have had the plague, the black death, the sweating sickness, from one end of the country to the other, in many cases cutting off I am

afraid to say how many of the population. The plague left only one-tenth of the people in some places after it had passed, and one is hardly capable of forming an idea of the wasteful, extravagant destruction of life consequent on its progress from one city to another during the middle ages. But we have heard nothing of it for a long time, because our condition, sanitarily speaking, is immensely improved. One cannot read the old chronicles without perceiving that the surroundings and habits of the people in this happy England of ours, as it used to be called, were most unwholesome up to within the last two or three centuries.

Our scientific physicians are beginning to be of opinion that what we call "seeds of disease" are really living germs, that there are actual morbific organisms in the air we breathe and in the water we drink when that air or water has been contaminated in some way. These organisms are capable of multiplying themselves enormously within the body and producing various symptoms that we recognise in diphtheria, typhoid fever, scarlet fever, or smallpox—diseases of what we call the zymotic class.[1] Whether that be true or not—and there are many indications of its truth—the fact is that there are germs or seeds of disease *imported from without.* There can be no

[1] A full exposition of this subject will be found in *The Germ Theory of Disease.* By T. Maclagan, M.D.

doubt whatever in the mind of any one who reads the account of the transmission of the plague or the progress of the cholera from the sunderbunds of Bengal to England, that diseases of that class are propagated by communication. There is a *materies morbi*, whether we can single it out and examine it or not, that is transferred from one district to another and from one individual to another, and that causes the reproduction of the malady wheresoever it goes.

There is, however, something more required than conveyance. You must not only have the seed but the soil; not only the germs but a fitting nidus for their reception. There are some persons, in certain conditions, who can walk, as it were, shot proof, through the thickest contagion. They do not find themselves affected by it. For instance, supposing any one has had typhus fever, he is generally proof against a second attack of it. When once he has been thus acclimatised, if you will allow the expression, he can go into the wards of a hospital, or into a little, badly-ventilated room, in which the fever poison is rife, with almost absolute impunity. He is protected somehow or other against the recurrent action of the poison, because he has passed through the fever formerly. I take that simply as an illustration of the fact that you not only require the seeds but the fitting soil into which they may fall, if they are to bear their fruitage in disease.

Now there are conditions in which there is a strange

readiness or preparedness on the part of communities as well as individuals for the reception of various seeds of disease. I believe there was a marked instance of that in England as shown in the history of the sweating sickness. Strangely enough this disease spread to France, Germany, &c., but only (with rare exceptions) attacked Englishmen wherever they were found.[1] If we read the accounts of the national habits of this time, we find that the clothing was immoderately warm, soap was seldom used, and the "intemperance, or excessive diet of England," was a reproach among other nations. And in these three national conditions of life we can find ample explanation of this preparedness for the seeds of this strange and destructive malady.

Physicians generally classify the two things I have spoken of—the seed and the soil—as *exciting* and *predisposing* causes of disease. You will find it convenient to note this distinction. Exciting causes are those acting upon us from without; predisposing causes are the readinesses or fitnesses of individuals, at different times, to be affected by these exciting causes. Supposing, for instance, five individuals were exposed throughout a cold winter night to the action of the lowered temperature when travelling by coach or railway. Of these five one may have an attack of pleurisy; another may have an attack of rheumatism;

[1] Guy's *Lectures on Public Health*, p. 63.

another may have an attack of bronchitis; a fourth may suffer from inflammation of the lungs; while another may escape without any bad effects whatsoever. The difference would be determined by the fact that in one case there was a predisposition to pleurisy, in others a predisposition to rheumatism, or inflammation, or bronchitis, and in the other no particular predisposition or weakness.[1] A man like Charles Kingsley could write in praise of the east wind. There are not many of us who could do that; at all events, we would not be telling the truth if we did. There are some people who say, "Is not this fine, seasonable weather?"[2] They really enjoy it. But there are others who do not enjoy it at all. Those who enjoy it are braced up by it, because they have no predisposition to be acted on by the lower temperature that surrounds us. Others are weaker and feebler in circulation, consequently they are shivering from the keenness of the cold; they do not like it at all, but positively and painfully suffer from it. It is very well known that when the *barometer* falls, certain diseases of the lungs are exasperated and get worse. If we have a fog in the city, you will find some people going about saying, "Oh, this miserable weather!" Others are lively and brisk; they can discharge their duties in a fog as well as in the clearest sunshine. The

[1] See Williams's *Principles of Medicine*, p. 6.
[2] December, 1879.

difference is in the condition of the people. Feebleness or preparedness to be affected by the fall of the barometer or the thermometer marks a certain want of vitality, while others who are proof against these influences possess a greater fulness of life.

We must endeavour to exterminate the seeds of disease as far as we can. There are, however, some exciting causes of disease that we cannot reach. We cannot alter the pressure of the atmosphere; that is not in our power. Nor can we change the seasonal condition at present, and obtain from the sun as much heat as we want. Do what we will, we have no power to affect these atmospheric and seasonal influences. But there are other causes that we can deal with. There are seeds of disease that we can destroy though we may not be able distinctly to separate and recognise them. There are many diseases quite preventible, and it is calculated that the deaths caused by these amount to 120,000 a year in this country alone. And that calculation, let me tell you, is not an exaggerated one. There is a great difference between the mortality in different towns. But there is no reason why the lowest mortality should not be the figure at which the mortality in every town and city in the land should stand; and the *excess* is the number of deaths that might be prevented. And deaths are really a loss to the country. Some people may talk as if it were a wise arrangement of Providence that a number

of children are cut off before they reach the age of five years; they may argue that we would have an over-abundant population if all the children lived. But, even in an economic sense, as long as you have disease and death that can be prevented, you have the wealth of the country lessened. Besides, this country has not hitherto had the population that it can fully bear, and when that comes to be larger than it can bear, the world is wide, and we have a great many outlets, and our fair share of enterprise. Apart, however, from all prudential calculations, these children have a right to live, and it is nothing less than a "massacre of the innocents" if we consent to see them slain, year after year, and take no means for preventing their death.

Why, I read that, in the island of St. Kilda, out of every ten children born nine die within a fortnight of infantile convulsions, because of the filth in the houses of the people on the island.[1] It is a very painful and portentous fact that of all the children born in this country (about a million every year), 260,000—more than a quarter—die before they reach the age of five years! I do not mean to say that all these deaths could be prevented, but I am quite certain that a great many of them could. There are no lives more susceptible to certain insanitary influences

[1] Health Lectures delivered in Manchester, 1878–9. Lecture by Arthur Ransome, M.D., on *Long Life, and the Causes that prevent It.*

than young lives, and they succumb very readily when care is not taken to guard them against such influences.

I have not as yet adverted to the weaknesses and unhealthy tendencies that come to us by *inheritance*. We have not had the good fortune to be born so early as the patriarchs. Their constitutions were not spoiled by thousands of weak and foolish ancestors. Our ancestry goes very far back, and many of us are born into the world with weakly frames. We have seeds of disease inherited directly from those who have gone before, so that we are at a disadvantage all our days. It is a strange fact, however, if fact it be, that some of those people who have lived longest, such as that old man called "Old Parr"—I do not know how long he lived exactly, but it was to a great age—at all events, this is said concerning him, that when he was a child he was very sickly, and was not expected to live. When a boy and when a young man he was still of a very feeble constitution. On that account he learned early to take good care of himself, and, by dint of constant watchfulness and prudence, he reached his celebrated antiquity. Even those of us who have delicate constitutions, and have inherited weakness from those who have gone before, can have a fairly long life, and live to good purpose, if we carefully guard against certain injurious actions and habits which, in many cases, are more delete-

rious than any hereditary influence. "Wash and be clean," Dr. Lyon Playfair said some years ago. And I do not know a more emphatic lesson that could be read to all the people of this country than is contained in that simple sentence. It was spoken to Naaman long ago, and it was the healing of him. I believe it would be the health of thousands in this country, if attended to. It would remove now, not leprosy, but much tendency to disease and aptness to succumb under its attacks. Lord Palmerston once said, that dirt was matter in the wrong place, and it is most certainly in the wrong place when it aids in the production of disease. Careful removal from the skin of all accumulations on its surface is essential to vigorous health.

In breathing we not only exhale carbonic acid gas, which vitiates the air of the room in which we are sitting, we also give off decomposing and poisonous animal matter; and this we can only get rid of by the utmost cleanliness in our homes and in our persons.

It has been ascertained that cholera may be effectually propagated by means of drinking water. I remember the story of the Aldgate pump. People were in the habit of sending for draughts of its fine clear sparkling water. There was an outbreak of cholera of a most alarming kind some years ago, which was manifestly traceable to this Aldgate pump. There were men

working in a neighbouring brewhouse who had a well of their own. These escaped, not because they drank beer, but because they did not drink the Aldgate mixture. I say that, because other people drank plenty of beer and yet succumbed to the cholera. It is well enough known that those who are in the habit of drinking beer and spirits succumb very easily. One of the early victims was a good old lady who had long been in the habit of sending regularly to this pump from a great distance. A niece who was visiting her was also one of the victims. It was discovered that the water in the pump was loaded with excrementitious matter, and this fired the choleraic explosion.

Many similar illustrations have come to light since. Disease germs have been known to get into water, from the water into the milk-pail, and into the milk itself, causing an outbreak of typhoid fever in different districts. Many of you will remember how that Dr. Murchison suggested this explanation of an outbreak of fever that occurred in Mayfair, when the milk from a certain farm, at which there was a case of this fever, nearly poisoned a whole district.

We are apt to forget, however, that air may be poisoned as effectually as water. In some cases we may breathe an atmosphere loaded with the products of disease, and thus, by infection, as we say, we may have a similar diseased action set up within our own bodies. Or we may introduce into our blood, through

the lungs, some injurious gases resulting from the decomposition of organic matter; or we may inhale some exhalations from living healthy bodies, which having been thrown out by them, it is not beneficial for us to take in. In all these cases, with perhaps the exception of the first, the evil effects may not be immediately perceptible.

We are accustomed to think that poisons acting on the body produce marked results within a definite time; and when such results are not soon detected we are slow to admit that there is any evidence of poisonous action. We have to learn that we may be poisoned as really, though not so rapidly, by the frequently repeated administration of smaller doses that are apparently innocuous. While this is much more widely true than is at present generally supposed, it is capable of very complete and instructive demonstration, so far as the condition of the air which we breathe is concerned. It can be shown, beyond the possibility of denial, that the inhalation of polluted air gradually lowers our physical tone and lessens our vitality. We have further to note that this deterioration of condition follows if we continue for some time to breathe an atmosphere that does not contain its normal constituents. I may remind you that oxygen is the element in air which is available for life purposes. This is consumed both by breathing and combustion. When air is taken into the lungs, or used in the pro-

duction of heat and flame, the larger part of the oxygen enters into combination with carbon, and is given off as carbonic acid gas. This gas, familiarly known as choke-damp, so dangerous in mines, is poisonous. Breathing it in large quantities is fatal; and breathing it in small quantity is injurious. So that air which has been respired or burned has had the oxygen taken from it which we need, and has had carbonic acid gas added to it which we ought to dread. Many volumes have been written on the unwholesomeness of air thus vitiated; but I fear that a great many more must be written before the seriousness of this evil succeeds in commanding the attention which it urgently claims. Even when we do not suffer at once from breathing this noxious atmosphere, we suffer from general malaise and feebleness as certain consequences. Indeed there is startling evidence to show that one of the frequent and fatal diseases of our country — tubercular consumption — is more or less directly attributable to this cause. Careful observation has shown that its frequency and fatality are exactly proportioned to these alterations in the air breathed, and every rational method of prevention or cure makes provision for an unlimited supply of pure, vital air.

I am not going away from my subject, or attempting to ride a hobby, when I say that of all the causes producing weakness there is not in this country a

greater or worse than intemperance. I am speaking from the physiological platform, and not as the advocate of teetotalism or any other "ism" whatever. No one who has given attention to the subject is unaware that of the causes of weakness in this country, intemperance may not unreasonably be said to equal all the rest put together. I believe that drinking strong drinks within even what are known as the bounds of moderation produces a weakened condition of the *body that makes it less able to perform its normal* amount of work, and more likely to succumb not only under extraordinary pressure, but under the ordinary pressure of business life. We must take care that nothing is put into our bodies that will lessen their vigour or make them less able to perform their functions. It has been calculated that 100,000 lives are lost in this country every year through intemperance. I suppose the lowest calculation that would be made would be that at least 50,000 are lost, though I do not think the higher estimate at all exaggerated. But take this lower estimate; what an immense sacrifice of life it is! If we lost 50,000 men in a campaign we should think we had lost a tremendous number, and yet we lose more than that every year through this single vice. You cannot wonder that some people are greatly incensed against intemperance, and are anxious to bring it to an end by any available means. Nor can you blame this exasperation. Anything that will help

us to prevent this immense yearly sacrifice of life is warrantable, and more than warrantable, within the limits of sound sense and prudence.

Now, young men, let me say very deliberately that I do not think any of you need strong drink. There might, perhaps, be a good case made out in some circumstances for its medicinal use, and it is prescribed by some physicians in the weakness of old age. But I have not got old men here, and if I had I would not say anything to encourage them to drink. But for us, young men, there is no excuse whatever. We certainly do not need alcohol.

I sometimes fear that the attention bestowed, wisely and necessarily enough, on the *external* causes of disease, may throw altogether into shadow the necessity of endeavouring to obviate the *internal.* There are two ways of saving the weak. Either you may shelter them from the cold blast or you may make them strong enough to face it without fear. We cannot afford to neglect either method. And as individuals the latter is more within our own control. By avoiding all well-known causes of debility; by rational and reasonable precautions in eating and drinking; by avoiding equally over-fatigue and indolence; by cheerfulness and obedience to those who are truly our superiors, we can do much to make "our days long upon the land."

VIII.

RESULTS OF LIFE.

THERE are some teachers who are specially urgent in advising their pupils to be "careless of consequences." I confess that these words always sound to my mind very suspiciously. In the sphere of fact, our best safeguard is exact and thorough knowledge; but in matters of belief that are to influence our conduct, and especially in matters of belief that are mainly founded on inferential arguments, we may fairly look at the results that are likely to follow. I have not, in the course of the lectures to which you have listened, urged any argument, drawn from the consequences, against the theories of life that have been propounded by certain scientists in our own time. You must not, however, construe this into an admission that these consequences ought not to have their due weight in our dealing with such theories.

There are two cases, at least, in which we may fairly look at results before reaching a conclusion. You are aware that the *reductio ad absurdum* is not an unfair argument when fairly introduced and applied. If we can prove that certain consequences, improbable, im-

possible, or ridiculous, follow from certain propositions, that is a sufficient reason, in many cases, for rejecting these propositions without further argument. And in many other instances, when we find that *hurtful* consequences are sure to follow—injurious action upon society or upon men individually—we are, at least, put on our guard in dealing with the hypotheses that make these results certain. Now, I venture to say, if we accept the teachings of certain schools in our own time, we must come to this definite conclusion: that man occupies precisely the same position as the other animals with which he is surrounded, and that he has no higher law to guide him than the law which guides and governs them. Some are ready enough to urge this conclusion with all its direful consequences. These are the most logical, but they are not the most likely to gain disciples. Others, by far the more influential, insist that man should regulate his conduct by some not very clearly explained principles, apart altogether from such rules as are determined only by his higher character, and by what we deem to be his true position in relation to God and eternity. Utilitarianism, as a theory of morals, has been fully described and widely disseminated by our periodical literature. In its earlier days it was maintained on purely selfish grounds. It it best for us, the teachers of that system formerly said, to live according to a definite fashion, and for our own sakes we ought

to avoid certain vices, and to cultivate certain virtues. In our time, utilitarianism, as taught by Mr. John Stuart Mill and others like-minded, presents a much more captivating doctrine. They endeavour to lead men to do right mainly for the right's sake; founding their knowledge and determination of right on principles of utility. Conduct is not virtuous, according to this teaching, that is not based somehow or other on principles of virtue; and when we recognise that a certain line of action conduces to the greatest happiness of the greatest number—to the good of society in general—we ought to devote ourselves to that with our whole heart and soul. I am not prepared to say that there is not much to recommend it in a theory of morals thus stated, but I question whether you can find either consistency in its advocates or any real foundation for itself. John Stuart Mill, in a very well-known passage, said if he were asked to worship an almighty, cruel being, he would rather go to hell than give reverence to any such being. And it has been said, I think with some measure of cleverness as well as sarcasm, that here we have the apostle of utilitarianism—the greatest happiness of the greatest number—declaring that not only he himself will go to eternal perdition sooner than offer such worship, but he will conduct all mankind with him, so far as he possibly can, to the same eternal perdition, *for the greatest happiness of the greatest number!*[1] The truth

[1] *Darwinism in Morals*, p 6. By Frances Power Cobbe.

is, our friends who adopt this theory and advocate it are not able to rid their minds of Christian influences or Christian facts. Whether these facts exist in the form of "organised experiences," as Mr. Herbert Spencer would tell us, or whether they have come to us partly by teaching, and partly by the intuitions of conscience, we find that they exercise a large influence even on those who discard the Bible altogether as the rule of conduct. And we must have a community made up purely and altogether of those who believe in this utilitarian theory, without any prejudices, without any partial teaching from ancestors or otherwise, before we can exactly determine the results that must follow. I am quite sure of this: if you spread generally the belief that men really occupy no higher platform than that of the beasts which perish, that we are constituted precisely as they are, that we can gain no knowledge of anything after death, that the soul of which we have been accustomed to speak is nothing more nor less than the action, in a particular direction, of the body—one of the double aspects of matter—and perishes when the body perishes, and that there is no God above us to give us His law now, to observe our conduct while here, and reward or punish us hereafter—I am quite certain if you get men generally to accept that creed, their conduct will be conditioned by their creed. I do not care to express my thoughts more definitely. I do not care to say

that their conduct will be of this sort or of that. I do not care to say they will be worse or better than those who have gone before. I content myself with this general statement, allowing unprejudiced minds to draw their own inferences as to what conduct would be the natural and necessary outcome of such a creed.

Of course we find our friends deprecating any interpretation of their creed that would lead us to think that manners must become worse supposing it were adopted. And we find them contending—honestly, I admit; for I do not deny any man's honesty in these matters of thought and argument—that, for their own part, they are quite as resolved to live what they esteem to be moral lives, without any regard to heaven above and without any regard to the consequences that may follow, as Christian men and women do who are under the influence of belief in God and belief in an eternal state of retribution hereafter. I am not speaking of what individuals may feel or profess, but I am speaking of what human nature is, and what human nature must continue to be, when I indicate that this creed of our beast-like origin and beast-like condition must determine our conduct in a beast-like direction. For my own part, I confess I cannot see how it could be otherwise. If it were possible for me to expunge from my mind all that I have learned about truth and virtue from the Word of God and

from Christian influence; if it were possible for me to believe that I occupy precisely the same position as either Darwin's ante-monkean monkey or any other supposed ancestral beast, I would infer logically that there was not, at least, *any obligation* resting on me to do otherwise than to give full play to my animal instincts, and enjoy as much of this present world as I safely might without injury to myself or to those with whom I might be associated in affection and interest. And depend upon it, gentlemen, if you get the great majority of mankind to accept this teaching—if you get, particularly, those who have less of this world's goods than their more fortunate neighbours, to believe that the short span of fifty or sixty years is the only time in which they can receive either good or evil, and that always and only the prize is to the strong and the reward to those who clutch it, I will not venture to prophesy what the result may be.[1] You can read it anticipatively in the French Revolution and in many other catastrophes that have happened in the world long before.

Now, I do not urge this argument until I have established, as I think I have done, that this theory of

[1] Professor Virchow of Berlin, in the course of his able address at Munich, said: "I will only hope that the descent theory (man from apes) may not entail all the alarm among ourselves which similar theories have produced in the neighbouring country. *Undoubtedly this theory, if it be rigorously carried out, has an uncommonly serious side, and it will not probably have escaped you that Socialism has established a sympathy with it.*"

evolution from material elements—up from the lower to the highest condition in which we find man now placed—breaks down at every stage at which evidence ought to be adduced. There is no proof along the whole line, from beginning to end, that we have such an evolution manifested in this world. We find, for instance, that there is no evidence that matter becomes at any time possessed of life by its own proper action. Cuvier said long ago that the elements are under the influence of what we recognise as chemical affinities. In living forms they become, somehow or other, superior to these chemical affinities, and act after a new fashion; and it is impossible to conceive that elements should undergo this transformation of their own proper motion. How they can change their character so as to lose their affinities and become able to direct and govern these affinities for different ends, to his mind, he says, passes comprehension. Then we have no evidence whatever—confessedly not the slightest even by those who differ from us in regard to this theory *toto cœlo*—that the non-living has ever spontaneously passed from that condition into the living. We have no evidence that there has been any transference of one species into another. Nor have we any evidence that any lower species has at any time been transformed into humanity.

I was speaking on a former occasion concerning the brain. Let me speak to-night for a little concerning

the mind. We hear a great deal about the relation between brain and mind. A very common idea is that brain matter has two relations—a physical relation and a psychical relation—a material and a mental state—and that these two are simply different states of one substance. Thus in brain matter we have the producer of all the thoughts and emotions that constitute our intellectual and our emotional existence. Many centuries ago this question was discussed in this form: whether mind has to the body the relation that a rower has to the boat in which he sits, or that harmony has to the harp from which it comes. Harmony coming from the harp ceases when the harp is broken. But then, don't you see—if we were inclined to pursue this metaphor further—it was by the fingers of the player that the harmony was produced, and the fingers of the player do not die with the breaking of the harp. They are competent to educe similar harmony from other harps at some other time. The question, however, may be stated in this form for practical purposes: Does thought come from the brain as music or harmony comes from the strings of a stringed instrument; or does some invisible player or agent act upon the brain, and by means of it produce results within the body, and beyond the body, as the rower does in the boat which he propels by the oar? I believe there is a something distinct and different from matter that we call mind, which

acts on matter; which acts, if you please, *by* matter, or, if you please further, which acts mainly through the brain; although I am not prepared to limit its action to the brain, or to admit that, when we speak of brain, we include all that is acted upon by this something that we call mind. Our wise and witty friend of Fleet Street gave a definition of both mind and matter some years ago that is worthy the attention of philosophers still. He put it in this form: "What is matter? Never mind! What is mind? No matter!" I think *Punch's* definition, for practical purposes, is an exceedingly good and useful one. It is impossible for us to tell what matter is exactly in definite terms—confessedly so. But we are sure of this, on the other hand, that whatever mind may be, it is something distinct from matter, although it makes itself known to us, in this material world, by its action on matter. We found it was necessary to predicate something that we call "life," because we were obliged to recognise a force beyond mechanical force, or chemical force, or electrical force, in living organisms. In the same way we are obliged to predicate something that we call "mind" in certain animals that give evidence of thought and feeling. Not that we are able to tell what this something is all round, or fairly express by any definition all that is contained in it, or explain its whole nature; but there is *a something* that we cannot explain in other terms, that is

not translatable into material language, that exists above and beyond matter, though still acting on it, for which we must find a name, and the best name that we can find is just this name that we give it.

Some of you are aware, probably, that Mr. Herbert Spencer says in his book on *First Principles* that there are two kinds of facts that are utterly unknowable. There are facts concerning supernatural existence and facts concerning natural existence. Looking at each and comparing them together, he found there was one element that underlay them in all instances, and that is the element of *mystery*. Underlying all religions there is belief in the existence of some power which we cannot fully comprehend or accurately describe. So there are certain facts in nature—ultimates—that we cannot resolve into anything else; for instance, time, space, matter, and motion. In all probability, he says, these unknowable things may be reconcileable. They are, however, outside the range of our faculties altogether, and it is in this sphere that we may safely leave them. The unknowable in religion and in science—we must put these aside for practical purposes and deal with such things as we can recognise by our senses and talk about in our language. Mr. Gladstone very fitly said, in a speech he made at Liverpool a few years ago, that this reminded him very much of what a gentleman said on one occasion to a very troublesome and unwelcome friend. He said to

him, "There are two sides to my house; you can take one of them. There is an *inside*; I will keep it: you can take the *outside*." In this way Mr. Spencer relegates religion and these ultimates in science to the outside, and says we are to concern ourselves only with facts that we can recognise and reason about. But you cannot write these things off by wishing to write them off. They are there, and although we cannot explain them we must recognize them. We must admit their existence, and proceed throughout, in all our calculations, on the acknowledged fact of their existence and operation.

Professor Tyndall says that the province of science is to explain the unknown by the known. And with considerable *naïveté* he gives an illustration of this. I do not think he exactly apprehended that it might be used *against* him, whilst he uses it very clearly for his own purposes. A German peasant, when railways were introduced, saw for the first time an engine dragging the waggons after it. He knew of no motion except that which could be produced, in similar circumstances, by means of horses. Looking at this strange machine, he made the very sapient remark, "*Es müssen doch Pferde darin sein*"—There must be horses inside.[1] He was explaining the unknown by means of the known. He knew what kind of force he was familiar with, and supposed that in this new

[1] *Fragments of Science*, vol. ii. p. 356.

mechanism, somehow or other, that force must be included in its structure. I venture to say that *Professor Tyndall, and many others besides, reason in the* same way from the known to the unknown, and introduce their materialistic facts and feelings and inferences into a sphere in which they have really no place. It is just an instance of what I referred to in my introductory lecture—*idola theatri*—the idols of the school. Some people are accustomed to look at facts with eyes that are trained to see in a very peculiar manner; and they read into these facts their own prepossessions and prejudices, and interpret them in the light of their own knowledge. It may be right enough in certain cases to interpret provisionally the unknown by the known, but only provisionally. We must be prepared to find, as in the case of the German peasant's theory, that our provisional explanation is altogether inadequate, and that there is a new power acting and working with which we have as yet made no acquaintance. We must find an exact conformity between our supposed cause and the effect, or we must be prepared to make other suppositions until we hit upon the exact interpretation, and discover the power and method that will apply definitely throughout to all the facts which we observe.

Now I confidently maintain that in our own case here are certain facts of our constitution that are as truly known to us as any facts can be to naturalists

—facts that will greatly help us in coming to a judgment *concerning our position and our destiny.* We may carefully observe the habits of the lower animals, and make ourselves familiar with all their operations, with their instincts, and the wonderful results of their instinctive actions. And we gain a certain amount of valuable knowledge by these observations, against which I would not utter a word. But it is possible for us, by means of reflection—consciousness if you will—to find out a great deal about the working of our own thoughts, the operation of our own mind and heart, and to become acquainted with some secrets of our inner life. I take it that consciousness is just as real an instrument of discovery as an eye aided even by the microscope or an ear aided even by the microphone. It tells us as truly what things exist within its own sphere. How do I know my eyes do not deceive me? I simply trust them. How do I know my ears do not deceive me? I simply trust them. Of course other eyes and other ears are just as trustworthy, or as little trustworthy, as mine are, and agreement with them does not make a thing more certain, although it adds to my confidence. How do I know that there is within me a whole world of feeling and a whole world of thought, except by means of consciousness? And that is quite as trustworthy as either my eye or my ear. And my consciousness is multiplied a

thousand-fold by the consciousness of others, and by my knowledge of the witness they give to the same facts and the same feelings. Moreover, without consciousness we cannot even read the intelligence which the senses bring to us. Scientists of a certain order are accustomed to scoff at philosophy and psychology, and to say that there is no psychology except that which is translatable in terms of physiology. But philosophy existed before science, and will not die earlier. We have ultimately in ourselves, even according to the materialistic teaching, the only authority and guide, whether for the interpretation of any of the facts of life, or for government in the duties of life.[1] What does this consciousness tell me? It tells me that I am a thinking being, and that my thoughts have a certain character altogether distinct from anything material. And by the confession of our "eminent modern thinkers" themselves, we cannot translate the actions of the brain into terms of consciousness, or into terms of mind. The two things are incompatible. They may be correlated, but they are not transformable. *The rays of light falling on my retina give me a picture of this room and those who are sitting in it* before me. How do I translate that into sight? How

[1] "Feeling and thought are much more real than anything else; they are the only things which we directly know to be real, all things else being merely the conditions on which these, in our present state of existence, depend."—*Three Essays on Religion*, p. 202. By John Stuart Mill.

are the waves borne in upon the retina, and, touching the sensitive nerve, translated into the consciousness that there are so many individuals sitting before me now and listening to what I am saying? We cannot transform material facts into mental facts; the consciousness that we have of them is different altogether from the sense and presentation of them. The two cannot be spoken of in the same terms.

Then there is another fact. My consciousness tells me that I am a free and responsible agent. Many deny this. There is a school of philosophy that is inclined to question it, and there are schools of science that speak of it in very strange language. Permit me to read an extract from Professor Tyndall bearing on this subject:—"Here, again, we are confronted with the question of moral responsibility, which, as it has been much talked of lately, it is desirable to meet. With the view of removing the fear of our falling back into the condition of 'the ape and tiger,' so sedulously excited by certain writers, I propose to grapple with this question in its rudest form, and in the most uncompromising way."

Let us see how he does it.

"'If,' says the robber, the ravisher, or the murderer, 'I act because I must act, what right have you to hold me responsible for my deeds?' The reply is, 'The right of society to protect itself against aggressive and injurious forces, whether they be bond or

free, forces of nature or forces of men.' 'Then,' retorts the criminal, 'you punish me for what I cannot help.' 'Let it be granted,' says society; 'but had you known that the treadmill or the gallows was certainly in store for you, you might have *helped*.'"[1]

I have seen it translated in this form: The criminal says, "Why punish me, because I cannot help doing what I did." Society replies, "I cannot help punishing you. I am as much bound by fate as you are." If the Professor does not mean that, he means nothing to the purpose. If he does, why introduce the gallows and retribution as an element that does not act on free will, as if the men are able to resist doing what they say they are fated to do? The fear of retribution acting on the criminal!—dear me, that is nothing new. Most of us have known that for years. But we bring in a great deal more than the gallows; we bring in remorse; we bring in the law of God; we bring in future retribution; we bring in all these facts. Yet these same scientists say,

> The fear of hell's the hangman's whip
> To keep the rogues in order.

What is the gallows but a "hangman's whip to keep the rogues in order"? You cannot get on in this world without punishment; the only question is as to the duration and the nature of it—as to what kinds are most likely to effect the purpose. If it be

[1] *Fragments of Science*, vol. ii. p. 365.

true that men are absolutely fated to do evil, constrained to it by some strange physical force that leaves them no choice in the matter, then I declare that there is no responsibility. But men are not in that condition. Professor Tyndall goes on, in a very interesting paragraph, to say, "One is inclined to argue, 'Well, if that is the case, I need not endeavour to persuade men to do right, because they must do wrong if they are fated to do wrong.' But," says the Professor, "your arguments may be part of the fate that induces the man to do right." But we are not advancing a step so long as we use such arguments as these. The mischiefs and sufferings that follow wrong-doing and the rewards that follow well-doing are a part of God's moral government of the world—and eternity behind and beyond them all to induce us to do right and to avoid doing wrong. And more than that, and higher than that, we have, if we believe the Christian doctrine, the Lord Jesus Christ coming into this world, taking upon Himself our sin, bearing our punishment, and giving to us His own life, not that we may do *His* work, but that He may work in us both to will and to do of His good pleasure, so that we may progress in the Divine life, "escaping the pollution that is in the world through lust." And while we admit that these two things are true—God's omnipotence and His eternal purpose—we maintain equally the responsibility conditioned by

freedom of action on the part of man the creature, and his *full accountableness* whether he be guided and influenced merely by this world, with its sins and the sorrows that follow them, or by the grand gospel of the Lord Jesus Christ, and that life of His which comes to us through His death to conquer men's minds and to make them *willing* to yield themselves unto Him, "as those that are alive from the dead, and their members as instruments of righteousness unto God."

I feel I am transgressing a little in speaking of these spiritual things—I do not mean transgressing on your patience and beliet—but beyond the strict limits of science within which I have been confining myself mainly. Because my object is simply to show that on the ground of science we have nothing to fear. Altogether, apart from the Bible, there is nothing in the ascertained knowledge of the times that may give us heed or pause in regard to our Christian belief. Instead of there being anything recognised and real in this Divine realm in which many are working, there has been nothing yet discovered (nor, I would add, is there likely to be any discovery) to alter our faith either in God our Maker or the Lord Jesus Christ our Saviour. Many who are inclined, readily enough, to admit the gradual transformation of man from a lower to a higher condition, so far as his body is concerned, take exception when they come to speak of mental

development, and take greater exception when they come to speak of moral development. And yet I believe these things hang together. I believe if you prove that the body is simply and only developed after a definite fashion, you have at least a presumption that the mind and even the moral feelings may have sprung up in the same way. Indeed, both Mr. Herbert Spencer and Mr. Darwin have endeavoured to show that morality originated from the experiences that have been gained in the progress from the lower condition to the higher. Mr. Spencer says that a great many of our so-called intuitions, our judgments in regard to right and wrong, are simply organised experiences of pleasure and pain, transmitted to us through past generations; that though we are inclined to think that they spring up in us originally, and have all the force of messages from above, they are simply an aggregation of a great many individual experiences transmitted from father to son, and from father to son, right on along the line, until they have come to be in us habits, or second nature, and have all the force of something novel and original. I do not see how you can evade that if you adopt this principle of evolution. At the same time I must ask your recognition of this fact that I gain from consciousness, namely, that there is in us, in regard to this question, something quite different from *judgment* either in regard to pleasure or pain, or usefulness, or hurtfulness.

Mr. Wallace—I think it right to give him the credit of this statement; it is a very noteworthy one as coming from such a quarter—maintains that the moral characteristics of man cannot be explained on the principles of evolution. You know he has as much claim to be the discoverer of the theory of the origin of species by natural selection as Mr. Darwin. He had worked it out for himself independently, and it was only an accident of time and circumstance that prevented him giving it first to the world. Yet he says in his book on *Natural Selection* that both in mind and morals man stands on a platform alone, and there is no accounting, he adds (after having made himself familiar with the arguments on the other side), for the moral instincts and actions of human beings on any such theory applied to his past history. He gives this one instance. There are some tribes in India, such as the Kurubars and the Santhals, in which there is an innate sense of truthfulness that marks them off from any other of the tribes with which they are in close relation. It is quite a common thing for other people to say of them: They may be depended on, for they never tell anything but the truth. "A number of Santhals," he says, "were taken prisoners after an insurrection. In order to be more useful in making money they were sent to work at some distance, simply giving their parole or promise that they would not attempt to escape. After some time cholera attacked them and

they were obliged to leave; but every man of them returned and gave up his earnings to the guard. Two hundred savages travelled back thirty miles to their captors with the money they had received, tied up in their girdles, compelled to do so only by the sacredness of their promise."[1] Mr. Wallace points to this fact as proving that there is in some men a *moral sense* of the sanctity and holiness of truth.

I have often said, and I say it again, that conscience in man is simply a sense of *oughtness*. I cannot express it in any other terms. People think they ought to do this or that, and they think very differently. It is thought to be right by some to kill their aged parents. It is thought to be right by others to put to death young children. It is thought to be right, in certain circumstances, and by certain people, to steal; and in other cases it is thought to be right to tell lies. There are great varieties of judgments in regard to what is right, and it has been used as an argument against conscience that there is this diversity of feeling among different nations. Now I admit that there are great differences in knowledge and great differences in training and habit; great differences, if you will, in circumstances and temperament among nations on this globe. All these things condition their conclusions; but as soon as anything is apprehended to be *the right thing to be done*, there is,

[1] Wallace's *Contributions to the Theory of Natural Selection*, p. 353.

behind it and beyond it, the sense of *oughtness*, the feeling that it must be done whatever befals. We may form wrong judgments, but once a judgment is reached as to what duty is, oughtness comes in—not merely it is best, or most useful, or most pleasant in certain circumstances, but this I *ought to* do, this I *ought not* to leave undone, in any circumstances whatever. And that is universal. You find that throughout the world wherever you find man. How can you explain it? It cannot be explained except in relation to God, who gives us law. There is nothing can account for it but law; and a law implies a lawgiver, some one to whom we are amenable, who has a right to regulate our conduct, whose expressed will must be accepted as the thing to be done, and whose expressed prohibition of any matter must be accepted as a sufficient reason why the thing is not to be done.

Now, taking these things together—for I must not dilate at this stage—we reach what I venture to call the "results of life." Life is a very small, pitiful thing—a mere question of trivial moment—in the light of evolution, in the light of agnostic philosophy and utilitarianism. I must confess I would sympathise very deeply with the philosophy current in certain German schools, if I could accept Darwinian and these other theories to which I have alluded. Schöpenhauer and Hartmann both tell us that this world is the worst of all possible worlds, and the best thing is to

get out of it as soon as we can. Life is, indeed, a very miserable thing on the plane of materialism. If this life be all, we are of all men most miserable. But it is a grand and noble thing when we regard it as the loom in which God is weaving His eternal work; and by means of us, little insignificant creatures though we be, He is manifesting unto the powers in heavenly places His manifold wisdom. Life is full of meaning, full of power, and full of grandeur, when we look at it in the light of God's word, and when we accept the teaching that word gives us concerning its present purposes and its eternal issues.

Nature craves for a revelation; and the revelation which God has given to us in Scripture explains, completes, and dignifies the lessons which we have learned in the lower school.

THE HUMAN BODY.

I.

THE ORGANISM.

ON the wall of Sir William Hamilton's class-room in the University of Edinburgh this inscription might be read:

> "THERE IS NOTHING GREAT ON EARTH BUT MAN.
> THERE IS NOTHING GREAT IN MAN BUT MIND."

Now, I doubt not, that among human kind, what ever pleas might be urged in behalf of other beings, there will be the most cordial unanimity in the acceptance of the first statement; but the latter is now very generally abandoned except by metaphysicians. It is supposed that, after all, the mind is simply another aspect of the body—the outcome of it in one direction —and that when we have exhausted the study of the physical components of man, we have left nothing further to examine.

I need hardly say to those who have listened to the former course of lectures, that I have no sympathy whatever with this doctrine. There is a tendency at the present time to look upon breadth of thought as of

peculiar value, and, I may add, as having a somewhat peculiar significance. Those who plume themselves on being broad thinkers are in the habit of importing certain forms of thought into all regions which they enter, and imposing them upon every fact that they find there. And that method they consider equivalent to width of study. There are some broad theologians, for example, who are inclined to imagine that all distinctive creeds are equally important or unimportant. Instead of recognising specific facts that have been reached, either in the study of nature, or in the reception of revelation, they endeavour to find out what they call the broadest truths that are accepted everywhere and in all times, and they regard these as being alone substantial and worthy of credit.

It seems to me that these men actually reverse the process on which they lay so much stress in regard to other matters. Evolution is a progress from the homogeneous to the heterogeneous, from the simple to the conplex. Consequently progress is inverted if we go back from the complex to the simple. And in the realm of thought many are going back to those elements that are most simple, and ignoring altogether historical advance and additions.

I have no sympathy, on the other hand, with those who are narrow enough to accept only one particular form of teaching, and to despise all others; and who

are inclined to look with suspicion, if not with dislike, upon all novelty, either in doctrine or practice. I believe that the true method, which we should earnestly cultivate, consists in having the mind open to all facts and all truths, whilst it is, at the same time, void of all prejudice and free from all distortion of vision. We ought to be prepared to recognise the revelation that God gives us in nature or elsewhere simply as it exists, and with utter fearlessness to receive into our creed all that is determined thereby. I am not inclined to argue, as some do, that the soul makes for itself a body. There is a school of philosophy which maintains that each soul organises for itself, as its own habitation, the particular form that is fitted for it; and that we have actually as framers of all the bodies that exist, certain souls or immaterial principles that fashion and form them according to their needs. But as little am I inclined, on the other hand, to believe that the soul is simply the action, in certain directions, of the body, and that it is not to be distinguished or separated in any sense whatever from that body wherewith it is associated. I recognise both. I recognise mind and material organism. And although I may not be able to understand all their mutual relations, or their mutual actions, I am not, on that account, at liberty to ignore either the one or the other. There are many facts that we are not able to correlate, but our in-

ability to correlate them or bring them together into harmonious union is no reason for the rejection of either. We must be content to wait until the time comes, if come it may, when we shall see more clearly the mutual connection of these facts. Or, if it does not come, as come it never may, we must be content still to hold to the facts, although we are unable to see in what way it is possible to harmonise them. In philosophy there are what are called antinomies, or antagonistic principles; but the fact of their being in antagonism has never been held sufficient to negative the evidence on which they individually rest.

I make these remarks, introductory to this course of lectures on "The Human Body," because we shall have to deal mainly throughout with the physical organism. And I would have you remember that in dealing with these material parts of our nature I never for a moment forget that we have given to us more than body. And while I am willing to admit all that can be proved in regard to the body, and to give full weight to every fact that I can learn in connection with it, I am not to be supposed at any time as teaching that the body is everything, or even that it is most important.

We may take the body as the foundation, using that term in the sense which these words suggest: "Our foundation is in the dust." We are related to

other animals very closely by our physical frame. Man is classed among the primates, and among the primates we find also the anthropoid apes, the Simiadæ and the Lemuridæ.[1] If we compare the structure of man's body with the form of the orang-outang, we find that there are very close resemblances between the two. Of course, I do not forget that there are marked differences between men and monkeys. But for the present our attention is called to these very striking similarities between the two classes. We find that the general outline is somewhat similar, and, if we examine the skeleton, we find that, with certain distinctions, there is still a marked resemblance in the conformation of both.

It may be argued, and has been, as you are aware, that this resemblance proves that there is a genetic connection between men and monkeys. For doubting that assertion I have formerly given several reasons.[2] I am not prepared to accept it in any sense whatever. But that there is a similarity of plan and physical purpose I admit as freely as any one who contends strongly for the other belief. Men and monkeys are formed very much on the same physical plan, and, so far as physical conditions are concerned, within very much the same range. Even those, however, who insist on the connection that I disavow admit

[1] Huxley's *Introduction to the Classification of Animals.*
[2] *Studies in Life,* p. 111 *et seq.*

that there is a very marked difference between the two classes in matters of mind and of feeling, and also in matters of conduct. And that is indeed all that, from our stand-point, we need for the present to claim and contend. If it were true that the bodies were exactly alike, so that you could not possibly distinguish between the figure of the monkey and the figure of the man, so that you required to come into close contact and personal dealing with either to distinguish which was which; the very fact that man is intelligent, that man has conscience and purpose, would mark out a very broad gulf existing between the two, and would be the best possible proof, even in the absence of every other distinction, that they stood on entirely different platforms.

There was a contention at one time between two very distinguished anatomists in regard to a very small difference that was supposed to exist between the brain of certain apes and the brain of man. I was inclined at that time to argue after this fashion: Suppose that *there were no difference*, that the brains were exactly alike in configuration, in weight, in mass, and in every other particular—that they were so nearly alike that if placed together, and you were not told beforehand that this belonged to the bestial tribe and that to the human, you could not possibly distinguish the one from the other; suppose the likeness was as exact and thorough as it is possible for likeness to be: yet in

the very fact that man is man, rational and responsible, and the monkey is monkey, irrational and irresponsible, you have proof of the fact that God breathed into man, and that "the inspiration of the Almighty giveth him understanding."

It is possible for us so to study nature that we recognise resemblances everywhere. And it is possible for us, on the other hand, so to study nature that we recognise distinctions everywhere. I believe that there are two classes of mind that part in these different directions. Some are always finding analogies, and others are always discovering dissimilitudes. The true state of mind and method that I desire to have and use, and that I would strongly urge all who wish to be well informed earnestly to seek and cultivate, is distinguished by the aptitude to recognise both resemblances and differences, and to give due weight to the one and to the other. Find out similarity where it exists, and note its true significance. Do not be afraid to do that. Find out also difference where it exists, and give it its due significance with the same frank fearlessness. We shall have a much smaller science, and a very much more barren science, if we confine our view either to the one or the other. If we desire to have true science, and make ourselves familiar with all the truths which nature contains, we must be prepared to exercise our judgment all round, and recognise with equal readiness likenesses and unlikenesses.

For the present it is my purpose to recognise likeness, and, as I have already said, I have no hesitation in admitting that man stands on the same platform, so far as his body is concerned, as other animals; that he belongs to the *Vertebrata*, class *Mammalia*, order *Primates*, or, as some prefer, *Bimana*. He is allied by very definite characteristics to the different apes to which I have alluded. And I am willing to admit, further, that when we examine his body, we find in it processes that are *akin*—I cannot use any other word fairly—to processes that we recognise in the inorganic world outside of us. We find that the laws of the diffusion of fluids and gases, for instance, hold good within man's organism just as they hold good in the realm of nature outside that organism. There are certain physical laws and certain chemical laws that have their place and operation within our body, just as they have in the world without. But to say that these laws operate within us, and to insist that they *alone* operate within us, and operate precisely as in inorganic nature, are two different things. To explain the whole action of man's organism by chemical and physical processes is a very different thing from acknowledging that chemical and physical processes are carried on within man's framework. The latter I readily and frankly admit; the former I as strenuously deny. And I deny it just on this account: that we find there are peculiar results and peculiar arrange-

ments that differentiate organic life from all other forms of existence whatever; and that it is impossible for us, without the presence of life, to secure any of the results that are readily enough produced wherever life is in operation. As I said in the former course, "Life" is a term that we must use.[1] It represents the sum of the functions of an animal—any animal that we regard at any particular time. And it alone can be recognised as the producer[2] of certain distinct effects that we easily perceive—effects that are unknown in any case to follow, except where it is present. We are obliged, if we use any term whatever to help us in the expression of the cause that acts in the production of these effects, to employ some term, and the most intelligible term is that simple word "Life," which we have used already on many occasions, and which is thoroughly adequate to the necessities of the case in the present state of our knowledge.

Man has a very complex organism, and stands, as we commonly say, at the head of the animal creation. If we consider his *structure;* if we study him, as scientists say, morphologically, we find that his *form* is most curiously complete, and thoroughly developed. If we study him, as scientists say, physiologically, that is, if we examine the *functions* that he performs, we find that these also are wondrously varied, and

[1] *Studies in Life*, p. 44.

[2] *Causa, sine quâ non.*

strangely adapted for the purposes which they are designed to fulfil. Still, if we examine more minutely into the nature of this structure and into the nature of these functions, we must come down to the lowest elements which are employed in building up the complete structure, and to the lowest actions of which these varied functions are the outcome and issue. When we do that we have to deal with what may be called the primary or elemental facts of life. These are very simple, but they are also very mysterious. Something like a speck of floating glue, something that has no definite form, that possesses the power of motion, and that is able to act in each direction apparently according to an impulse of its own, is the ultimate agent employed in building up all organisms—the organism of man as well as the simplest organism that we find floating in any of our wayside pools. What Dr. Lionel Beale has called BIOPLASM is the great weaver that forms the tissues of life and that builds up all the different organs in their wondrous complexity. The entire human body is built up by "structureless specks of matter." It has been said, you are aware, that there is a very suggestive similarity between the action of crystallisation and the action of organisms. From certain solutions in favourable circumstances crystals are deposited, and after these crystals have been formed, if by any accident any part is broken, by introducing the trun-

cated crystal into a proper solution, a part corresponding to that which it lost will be supplied, and it will regain its former completeness. And it has been hinted that, in the formation of crystals and in their reproduction of parts, we have something corresponding closely to the building up of organic beings, the repair of injuries, or the reproduction of lost parts. That there is a resemblance of a very vague sort we need not deny. But there is a marked distinction between the two processes that we can at once recognise as soon as it is stated. The crystal only gains parts by *accretion*, that is to say, by the deposit on its outer surface of one grain after another; but an organism weaves or builds up its structure from within. In the one case you have *addition*, in the other *growth*. And the organism grows by changing *dead* matter into *living* matter. It assimilates it, making it bear its own likeness and perform its own functions. If there is not a wide distinction in that simple fact I do not know where it is possible to find any distinction at all. Wherever we have life, in its simplest forms, we have this mysterious action. It can lay hold of certain materials outside of it that are not living and use them for its own purposes, by endowing them for the time being with its own life, enabling them to take part in its own processes. And whether we have it in the larger organism of man or in the smallest animalcule, we have this function performed that distinguishes,

throughout the whole of nature, the living from the lifeless.

Of course, when we have such a composite organism as in the human being, we have this carried on by a somewhat roundabout process. You are aware that we are continually losing material and continually adding material; yet it would be possible for any one in certain circumstances, from day to day or from week to week, to remain very much the same in weight, even though, in that time, he should pass through his body a very large amount of matter. Our expenditure and our income may be made to balance each other so nearly, that there is no appreciable margin, either on one side or the other. By every word we speak, by every action we perform, in every step we take in walking or running, we are wasting part of our body. When we take food, if it be thereafter properly digested and conveyed in the current of the blood to the different points where it is needed to supply the waste, we have material introduced that takes the place of that which has been spent. In that way we are enabled to preserve our integrity within certain limits. This continuous change is carried on through the whole term of life. I should have mentioned, perhaps, that while inorganic materials are in a state of what may be called stable equilibrium, remaining unchanged if not interfered with, organisms are in a state of unstable equilibrium, they are always

changing. In addition to that they pass through a definite cycle of changes. Each organism—I am speaking now specially of animal organisms—has its own appointed term of life, and during that term of life it passes through certain definite changes. For instance, in the child we have cartilage which in the adult becomes bone. Then in old age, when the limit of life is being reached, we find the cartilaginous or animal element in bone is lessened and that the earthy matter preponderates. The bone becomes more earthy, and consequently more fragile. It is well known that bones broken in childhood are more easily and deftly repaired than in advanced years, and much more easily than bones that are injured or broken in old age. There is a certain definite plane along which a living being moves; and its term of life has a fixed limit. While it continues to move along that plane, there is a continual motion taking place within itself. We are never in one stay for a single hour together. There are those continual processes of waste and repair carried on throughout the whole term of our being. And without any very delicate investigation, or without any very careful study, it is possible for us by means of certain—shall I call them organic—indicators to carry on this work fairly and well. We do not need, as some have done, to calculate the amount of our loss and to weigh out the amount of food we take, so as to balance the one precisely by the other. By means of our appetites and our natural

desires, we can maintain the balance fairly right all through a long life. The whole organism has been so delicately adjusted, that it is able to maintain life without the labour that might at first sight seem necessary in order to avoid excess on the one hand, or loss on the other.

It has been said, you are aware, that the action of man—not only the action of certain animals lower *in the scale, but the action of man himself—is what has been termed automatic; that man is an automaton.* An automaton is something self-moved, if we are to take the derivation of the term. And I would have no objection to the application of the word if you confine it to its exact significance. But the intention, in maintaining that man is an automaton, is to prove that somehow or other we do not possess that freedom of action and of motion which is necessary in order to responsibility, and which we think is essential to our existence as intelligent and accountable beings. Some statements have been made in certain quarters, that have been considered sufficient to warrant this conclusion.

But I must tell you, before talking of these statements, that the conclusion to which Professor Huxley comes, as formulated in his address at the Belfast meeting of the British Association for the Advancement of Science, is, that "man is a conscious automaton, having free-will in the only intelligible

sense, that is, being able to do as he likes."[1] This is a very strange outcome of the argument he uses, at all events so it appears at the first blush to ordinary minds, although it has a fuller meaning when it is examined more closely. We talk about Zoe or Psycho, for instance, at the Egyptian Hall, as automata. They are figures so constructed that they act in certain directions. But it would be absurd to suppose that men, *or animals of any kind, are figures containing* mechanism *after that fashion*, and wound up or prepared for performing a certain round of actions. There is a broad enough distinction easily recognised between the two classes of things.

But when we say that man is "a *conscious* automaton," we introduce another element, and we take away the strangeness from the first statement. He is self-moved in the sense of mechanism, for, I suppose, that is what is intended to be implied; at least, his motions are based entirely upon physical action and process, though he has all the time a certain consciousness or acquaintance with his own actions, thoughts, and feelings, which consciousness differentiates him from those other automata that are formed and arranged by human skill.

The main illustrations employed in support of this theory are these: Professor Huxley says, if you take a

[1] "On the Hypothesis that Animals are Automaton." *Fortnightly Review*, November, 1874.

frog, cut off its head, and place it on the palm of the hand, it will remain stationary, just as you place it, for a long period of time. Unless stimulated, it will not move. But if you carefully raise the hand so as *to bring it* to a vertical position, you will find that the frog gradually raises itself and lays hold by its fore limbs of the upper finger, so that it may prevent itself *from falling. And if you turn your hand carefully round, it will also go carefully round until it rests* quietly on the back of the hand. This, let it be noted, is *unconscious* automatism. The brain has been taken away, the organ which is supposed consciously to give direction to the muscles has been removed; and yet, without that means of becoming acquainted with danger, and without that means of taking precaution against the danger, it carefully preserves itself in the turning round of the hand.

I do not suppose that there is any unwillingness among physiologists to acknowledge that there are certain functions automatic in that sense. I suppose there are many physiologists who would admit that many of the instincts of the lower creatures are automatic, and that many of our own actions, which may have been conscious in the first instance, become automatic. That is to say, after we have acquired by habit certain modes of operation, we perform them without being conscious of our action at the time. It is a rather difficult task to learn to walk.

We have forgotten all about it; but children find it a hard thing to keep an upright position, and to advance on two limbs only without falling. Those who have learned to skate know that the acquirement has not been without its difficulties and dangers. But the child has a much more difficult task to perform in acquiring the habit of walking. And yet we now *daily walk in any direction without any consciousness of effort*; all the muscles are called into play as they are needed, so that we balance ourselves and advance one foot after the other without any thought or care. Walking has become, in a sense, automatic; we do it without thinking about it. Somehow the nervous action seems to run in the accustomed groove, the muscles seem to be called into play as they are needed without our attention being called to this one or to that. A great many actions can be performed in the same way very swiftly and easily as, for instance, playing an elaborate piece of music on the piano, or keeping up in the air four or five balls at one time. When we have acquired facility of execution, these things are done without any consciousness of effort, though there was a very large amount of conscious effort expended in learning. But this does not at all affect the fact that there are many other actions that are performed directly by a conscious and immediate effort. We resolve to walk to the right or to the left, and our limbs obey. If we do

not wish to go further in one direction, we diverge, or retrace our steps. We can interfere at any moment by bringing thought and purpose to bear on our progress. There are actions in the body that are carried on apart from consciousness altogether. The beating of the heart goes on when we are sleeping as well as when we are awake. We can interfere with the action of the lungs to some extent by holding our breath, or by taking a deep breath, and we modify the emission of air in speech; but, on the whole, this action is an independent one. But the fact that some actions are automatic, and that others may become so, does not prove that all actions are automatic. Admitting that in certain instances, such as that of the *headless* frog, there may be the possibility of certain actions being done in this way—and there is nothing startling in these actions to physiologists—there is, above and beyond them, the fact that *beings with heads* have a certain, direct, intelligent power to change their action in this direction or in that; and they can purposely interfere, to a great extent, even with some automatic actions themselves, and this *facultas* is higher and ampler than these other aptitudes of action which have been described.[1]

Professor Huxley quotes a very interesting pathological history in the course of his argument. A

[1] For further details consult subsequent lecture on "The Nervous System."

French soldier at the battle of Bazeilles, some years ago, was wounded by a bullet, which fractured one of the bones of the skull (the parietal), producing paralysis of the right side of his body. For about a year he remained in this condition. Within four months after the infliction of the injury he became subject to periodical brain-disturbances. These aberrations continued from fifteen to thirty hours, the interval between the times of their recurrence varying from fifteen to thirty days. During his lucid time he attended conscientiously to his duties as an attendant in the hospital. He was patient, obliging, and willing to help in everything. But suddenly, and without any warning to the bystander, he would pass into another condition, in which he seemed to be altogether unconscious. He could move about and smoke a cigarette; but he would smoke hay made up in the usual form as pleasantly as tobacco, seemingly unaware of the difference. He would drink a glass of vinegar or a solution of quinine as readily as water. He ate, drank, walked, smoked, rose and went to bed at his accustomed hours; but all the time, pins, etc., might be run into his body without producing any indication of pain.

The full details of the case you can read in Professor Huxley's paper in *The Fortnightly Review* for November, 1874. It is evidently adduced as an illustration of Automatism. I do not question the

facts observed, however strange they seem; I only contend that they do not prove that men are automata. Was he an automaton during the twenty-seven days of his normal conscious life? It seems to me that the illustration has another side altogether that is strangely overlooked, and that instead of proving the theory in support of which it is adduced, it is a fairly available argument against it. In his deranged condition the man's actions are automatic; but, then, this is a lower and lesser form of life. There is another state, and that the natural one, in which the man is able intelligently, purposely, and voluntarily to direct his actions and to control his movements. This is shown with special emphasis by a circumstance in the record, to which allusion is made by Professor Huxley in a foot-note. When the man was in his natural or normal state, he was, as has been said, very obliging and honest; but in the automatic condition he *was ready to steal anything on which he could lay his hands*[1]. I think this goes very far to establish the fact that man is something more than an automaton, something more even than a conscious automaton. For if any one is prepared to contend—and the contention is admissible—that this man during his automatic condition had his con-

[1] *British Medical Journal*, August 24, 1874. Quoted by Dr. Elam in article on "Automatism and Evolution" in *Contemporary Review*, October, 1876.

stitutional feelings and wishes brought into play, and that he was consequently ingrainedly a thief, then he must have been able to exercise a very strong volitional control when restored to his rational and fuller life, so that he laid his hands on nothing that did not belong to him!

But I daresay you noticed there was added to the statement, "Man is a conscious automaton," this further statement: "Having free-will in the only intelligible sense, being able to do exactly what he likes." Now of course Professor Huxley is aware that these words do not touch the controversy that exists between the advocates of free-will and the advocates of necessity. I do not think that the most determined advocate of necessity would refuse to admit that men everywhere are able to do what they like, that is to say, within the limits of the possible. Men everywhere can do what they *like.* The phrase is ambiguous, and avoids, if it does not conceal, the real problem. What we have to determine is, the possibility of changing the "liking," and, if it can be changed, the method by which this result can be reached.

These are the philosophical questions to be discussed, and the answer lies outside the range of Automatism. The influence and arguments of our fellow-men tell upon our actions, and, I venture to add, the influence and arguments of God, which we sum up in the expression "Divine Grace" form a most influ-

ential factor, accredited alike by history and experience. For our present purpose, however, it suffices to remember that we are not *driven* either by fatal or favourable necessity; that we have "choice" in our own power, as intelligences "looking before and after," absolutely and entirely; and that we have a corresponding sense of responsibility in choosing the right and refusing the wrong, or in doing the wrong while distinctly rejecting the right. That consciousness cannot be overborne. It belongs to us as men and women universally, and it is as valid a fact as any fact that we can find in material nature or in our physical organism.

I am afraid that I might take up too much time by dealing with this subject further. Before closing, let me say a few words in regard to the human organism generally. Looking at man as he appears, we can divide his physical structure superficially into three parts—the head, the trunk, and the limbs. The head contains the brain; the trunk contains the lungs, the heart, the liver, the stomach and other organs; the limbs are used for locomotion or purposes of prehension. If we look at the skeleton [pointing to one] we notice a bony framework which incloses the brain and other parts of the nervous system; and a bony framework enclosing the organs that are especially employed in the maintainence of the animal life. If you look at the skeleton placed sideways, you will find we have a

double tube, one of small calibre behind, and one of very large calibre in front.

In that posterior tube (the spinal cavity) which we can follow right up into the skull, we find the spinal marrow flowering at its summit into the brain. In the larger tube or cavity, we find what may be distinctively called the parts concerned with organic life. I believe that in these two we have representations given in a very broad sense of (1) the organism of animal life, and (2) the organism employed mainly in what we may call directive and rational life.

II.

THE TISSUES; THEIR STRUCTURE AND VARIETY.

IN the story of the exodus from Egypt, we read that when Moses and Aaron stood before Pharoah, Aaron cast down his rod and it became a serpent. The magicians of Egypt did the same thing by their enchantments, but Aaron's rod swallowed up the others. Thereafter, by the stretching out of the same rod, the waters of the Nile became blood; but the Egyptians also contrived to produce the same results. Then frogs were brought up over the land, and that marvel was imitated, in like manner. But, curiously enough, when the next miracle was wrought, the enchanters of Egypt confessed that they were unable to do likewise, and they acknowledged that therein was the finger of God.

Now, I venture to say, that it is possible to produce a colourable imitation of some of the results of life. To a certain extent, the chemist in his laboratory can imitate the processes, or, at all events, the results of the processes that are carried on in the living organism.

But there is a certain terminus reached beyond which it is impossible for him to go. It has been said by a very celebrated writer, that the gulf or gap between the organic and inorganic—the chasm yawning between the two—is being rapidly filled up.[1] If he had said that the bridge between the living and the non-living was being formed, his statement would have been much more startling, and would have evoked from biologists a readier denial. But even accepting the terms which he employs, we find that there is no relationship being established in reality between the two kingdoms in nature—the organic and the inorganic. *Nothing that takes part in any living process within the body* has ever yet been imitated by any of the arts or skill of the chemist. There are certain *organic products*, we acknowledge, that have been formed by chemical methods; but it has been hitherto found impossible to imitate muscular tissue even as it lies dead on the dissecting-table. Chemistry cannot even produce anything corresponding to the albuminous products given to us so widely and freely by the vegetable kingdom. As I said on a former occasion,[2] if it were possible to do this, then we could have unlimited supplies of food produced, notwithstanding the inclemency of the skies or the adverseness of seasonal conditions. But it is well and widely known, that no

[1] Herbert Spencer's *Essays*. Vol. iii. p. 237.
[2] *Studies in Life.*

artificial process yet known to chemistry can enable us to cross this boundary, or to produce even fit substitutes for the simplest products of that *vegetal organic life* on which we depend for nutriment and growth. No chemistry can originate life; it cannot even produce the material in a *lifeless* form that has once taken part in a living process, much less the living material with its own peculiar action.

And yet we are accustomed to hear a great deal at the present time about the *mechanism* of the human body. It is quite fashionable to compare this wonderful structure of ours to a nicely constructed and well-ordered machine. Evidently the purpose of this comparison is to suggest that we are under the same physical laws as other mechanisms, and that, to a great extent, if not altogether, the terms that are used in speaking of mechanisms external to us can be employed in describing our own bodily organism. I have no objection to the term "mechanism" or the word "machine," provided we clearly understand that we are using metaphorical language; and provided there be no intention of suggesting that there is a full comparison or relationship between the two. Such language is allowable if we remember that, though in some respects the body is like a machine, in other respects, it is altogether opposite and unlike. For purposes of comparison and for helping our conception of what is done within the body, we may speak

of it in connection with these resemblances, not, for a moment, forgetting the real permanent differences.

For instance, I may compare my watch and its mechanism to the human body, with its *vital* arrangements. Taking a very superficial view of the matter, I might say, just as I find that these elements enter into the composition of the human body—hydrogen, oxygen, nitrogen, and carbon, and some other fifteen not so widely used—so I discover that there are certain elements that enter into the composition of the watch. I find brass, iron, carbon (in the shape of diamonds), silicon (in the glass), and other elements. All these are combined to form this machine that we call a watch. Looking at it I find there is a seconds-hand that moves very apparently. There is a minute-hand and an hour-hand that move comparatively slowly. If I listen to it I find it emits sound. If I open it I find there is motion going on in different directions, conditioned by the wheels that are enclosed within the case. In all these respects it has a certain relation of a very superficial character to the human body. That too is made up of chemical elements, to a large extent, just as this watch it. It emits sounds as I speak. It moves as I lift my hand or walk. It has certain processes carried on within it, that can sometimes be seen through the walls of the chest, as in the beating of the heart; and other motions that are visible, as in the turning of the eye from one direction

to the other, or in the movement of the muscles. In these, and many other respects, there is a distinctly observable comparison fairly instituted between the bodily mechanism and this small piece of mechanism —a watch.

But did you ever know or hear of a watch that grew, or that put itself together, forming all its parts from other constituents existing and widely scattered in nature? Did you ever know or hear of a watch that originated from microscopic particles of matter, and gathered to itself the brass, iron, silicon, and carbon, and formed its wheels, its spring, its case, and its glass, so that it was fairly adapted, in course of time, for marking the hours and serving its own peculiar purposes? Did you ever know a watch that could repair itself if it became injured, and that produced wheels to take the place of wheels that were lost, or even teeth in the wheels to take the place of teeth that were worn away? Or that could repair any part of the outer covering, the glass, when it was cracked or broken, so that it became whole again as it was at first? Did you ever know or hear of a watch that could give origin to other little watches like itself, or in any other way continue the kind of mechanism indefinitely throughout a lengthened period of time? Did you ever know or hear of a watch without a maker, without some one who collected these different materials, and by his skill and knowledge and purpose arranged them in their definite

collocation for the marking of time, and for all the uses which he intended such a mechanism should serve?[1] And I venture to ask, after making these inquiries, Are there not more differences between the mechanism and the organism than there are resemblances? And are not the differences deeper and more important, by a great deal, than are the resemblances? Then why is it that we are continually being reminded nowadays of the resemblances, while the differences are ignored altogether? Why do certain scientists insist, over and over again, that in certain respects—which nobody denies or doubts—there is a comparison fairly to be instituted between machines or mechanisms and the human body? Why, when doing so, are they not equally careful to remind us that there are differences, thoroughgoing and essential differences, that mark out the two things as wholly and for ever distinct?

I have suggested the reason, and you do not need to read many books to find that it is borne out by the arguments that are raised on these resemblances. These scientists are very anxious to induce us to believe that there is no such thing as a specifically distinct organic kingdom at all. That everything that exists in the human body—brain, mind, and heart—are all within the domain of physical law; and that we are

[1] A full statement of essential differences between "Organisms and Machines" will be found in Lewes's *Physical Basis of Mind*, p. 59, *et seq*

not, in any important respect, differentiated in kind and character from the mechanisms wherewith we are surrounded. I am confident that no one who studies this matter with any care, or with any intention of grasping the truth, can be misled by this fallacious method of statement. When we examine the two things honestly, and when we look at them all round, we find marked distinctions between the two things—mechanisms and organisms—that are immensely greater than any obtrusive superficial resemblances that are apparent to the eye of the mere casual observer.

We know that a little germ of apparently structureless, jelly-like matter becomes in process of time a human body, with all its parts and functions. Now, there is contained in that simple fact a mystery of the most profound sort. This germ is able, somehow or other, to gather from all nature with which it is brought into contact in successive times, the very materials that are required for building up this complete framework, and for performing, through a definite period, all the actions that are peculiar to the human race.

And when we look at the fully formed human body, and examine into the processes that are carried on there, we find the same mystery meeting us still. Did you ever think of the varied combinations that take place in a garden where you have roses, cabbages, apple trees, peach trees, plum trees, and a great many other vegetables and trees of different kinds growing

together? You have all these varieties of vegetable life produced from the same soil, heated and lighted by the same sun, and watered by the same clouds. How is it that in one case we get the plum, in another case the apple, in another the beautiful rosebud or the full-blown rose? How is it that from the same materials, without any alteration in the slightest degree, so far as environment is concerned, we have such a vast difference in the results? Simply because each one has got the power of using these materials according to its own nature, according to its own capacity and skill—if you will allow me to use the expression—for receiving and building up, after a definite plan peculiar to itself, the various forces and substances that are common to all.

We find the same faculty and facility exhibited within the human body. All the tissues, all the membranes, all the organs and parts of every sort, are formed from one fluid, the blood, circulated throughout the organism by the heart. From this fluid, sometimes called "the material of life," or "the pabulum vitae," all the different parts of the body, every special organ, each distinct membrane and tissue receives what it requires. The lungs receive from it lung tissue; the liver, liver tissue; the heart, heart tissue; the brain, brain tissue. All these different organs form their own particular substance from this one fluid that bathes them all. It has been frequently said that each tissue or membrane or organ

possesses a specific power of selecting from the blood the material it requires.[1] The blood containing the elements that are requisite for the upbuilding of the body, these tissues, membranes, and organs are supposed, individually, to have the power of choosing and appropriating, each one for itself, the particular elements required for its well-being and work. More recently, however, we learn from microscopic examination, long continued and very thorough, that such language does not adequately represent the facts.

"A mass of bioplasm exposed to certain special conditions which differ as regards heat, moisture, pabulum, and which vary with every kind of bioplasm, grows, divides, and subdivides into multitudes of masses. Each of these grows and subdivides in the same manner until vast numbers result. By these apparently similar masses of bioplasm, different tissues, organs, and members are formed. Some give rise to tubes which carry the nutrient fluid to all parts of the body. Some are concerned in taking oxygen from the atmosphere and giving up carbonic acid to it. Others separate materials resulting from decay, and

[1] Sir James Paget discusses, in a most interesting and suggestive manner, a principle, the germ of which he finds in the following sentence from Treviranus: "Each single part of the body in respect to its nutrition stands to the whole body in the relation of an excreted substance." Sir James finds in this a philosophical explanation of "permanently rudimental organs," etc., which evolutionists have so confidently adduced as inexplicable, except by their theory.—Paget's *Lectures on Surgical Pathology*, p. 17, *et seq.* Ed. 1863.

convert these into substances which can be easily removed altogether from the body. Other collections of bioplasm give rise to bone, to nerve, to muscle, and other tissues; while from others, organs so delicate as the eye and the ear proceed by gradual process of development, and convince us of the marvellous and inexplicable powers possessed by the formless bioplasm, by which alone any of them could be formed."[1]

Instead of these different tissues each doing its own differentiated work itself, this structureless, clear, jelly-like substance, called bioplasm,[2] is continually aetive in all the different parts of the body, like an invisible workman, building up various tissues and carrying out all the vital processes of the body throughout the term of its existence. This substance that we call bioplasm, or rather these strange activities that we may call *bioplasts—little structureless specks of clear,* jelly-like matter, are able, I cannot tell you how, to build up a lung, or a heart, or a liver, or a brain. They are able, from their pabulum, which we call food, transformed, not without their presence and co-operation, into blood, to construct all the different parts of this multiple and marvellous organism. Aye, and not only that, but to break down and send away such matter as may be no longer required for the use of the body; to use up such materials as, having been

[1] *Bioplasm.* By Lionel S. Beale, M.B., F.R.S., p. 13.
[2] See *Studies in Life*, pp. 40, 41.

formed into tissues, can be employed now to better purpose in maintaining the heat of the body, or in doing its work.

There are many varieties of tissue noted in ordinary descriptions of the human body. We may, however, conveniently class them as connective tissues, muscular tissues, and nervous tissues. Still, in order to have a wider view of the subject, we may look at such as we find, for instance, in making a section of the arm. If I were to cut through the arm of a dead body, we would find in the first instance that the knife, passing by any hairs that might be growing on the surface, would divide the integument or skin. The thin film on the surface we find to be lifeless; it is non-sensitive, like the outer rim of the nails. The hairs on our head, as we all know, can be cut without pain, although at the base or roots they are living and growing, and you may soon perceive that there is sensation if you pull them, or attempt to extract any number conjointly. So in this outer part of the skin we have a superficial layer of dead material that can be separated from the body without any suffering. Indeed, to speak correctly, it has been already thrown off.

Then cutting still deeper, penetrating the true skin, which is highly sensitive, we meet with a filmy-looking substance containing fatty matter in varying quantities, which is really connective tissue enclosing fat cells, though from its contents it is commonly called

adipose tissue. This gives roundness or symmetry to the arms. Going still deeper we come to the red mass, familiarly known to us as the "lean" of meat, or, more accurately, as muscle. We find certain vessels traversing this fleshy mass, having a distinct structure and office, as channels for the blood in its outward or inward flow. We find also in their neighbourhood certain glistening cords that we call nerves. Going still deeper we come to the bone. This is hard and difficult to cut. On sawing through it we find in its centre more fatty matter or adipose tissue, commonly called marrow.

All these different tissues we find in a section of the forearm: the integument, or skin on the surface; the connective adipose tissue; muscular tissue; vascular tissue, or the tissue of the vessels; nervous tissue (nerve cords); osseous tissue, the tissue of the bones; and again adipose tissue, or the tissue of the marrow contained within the bone. Again: if I direct my attention to the trunk, or torso, I find within it a peculiar tissue that we may call lung tissue, adapted for certain reactions between the air and the blood. Then I find the heart composed of muscular tissue, with some structural additions, constituting it a live force-pump for the circulation of the blood throughout the body. I find the liver also there with its special glandular structure—*i.e.*, containing certain glands, or organs of secretion. These glands, or secreting organs, perform

different functions, on which I do not now dwell. We have all these and other organs, membranes, or tissues within the trunk, or torso. And it is somewhat confusing—allow me to remark—at least for the young student, to be obliged to examine them in detail and in their different relations. For practical purposes, and especially for the accomplishment of my design in these lectures, it is sufficient to class them generally, which we may do fairly, as connective tissue, muscular tissue, and nervous tissue. Connective tissue used to be called cellular tissue. It was regarded as the *basis* of all the others. It was said that in it were deposited all the elements required to form the distinct tissues of every sort: nerve matter deposited in the connective tissue to form nervous tissue, muscular matter to form muscular tissue, and so on. We know now that this is not the exact representation; nevertheless, connective tissue is found pervading the whole organism, entering into every part minutely, so that if it were possible to remove from the human body every particle of every other kind of tissue, and leave only the connective tissue remaining, we would have a perfect outline in every detail of the human body. The connective tissue forms what we may call, in a real sense, the foundation or *substratum* of the whole organism. We find it in bone; where, in addition to this tissue, which in itself is comparatively light, we have earthy material deposited to give solidity. We find it in the

teeth; and in them it is associated with what is called "dentine," to give the specific hardness that they require for the performance of their functions. We find it in every part of the body. And it is all built up by these simple, structureless, clear, jelly-like particles that I have spoken of as bioplasts. And it is maintained in its completeness by their continuous unresting action. There is not a particle of the human body, 1-250th part of an inch in diameter, that has not within it one or more of these bioplasts. You cannot find 1-250th part of an inch in the whole frame in which this living action is not carried on by these strange, simple bodies. We find within the body what we may call nutriment on one side, and formed tissue on the other, and, between the two, the bioplasts. And there is no passage from this one form of nutriment to that other form of tissue except through the bioplasts. Given all the nutriment, there is no created power in the universe that can change it into living tissue otherwise than by its translation into this bioplastic condition, and its becoming for a definite period of time alive with that life. You may have all the elements that are required for forming any tissue, but it is impossible to prepare that tissue out of these elements unless they first assume this particular bioplastic form.

The importance of this *living* matter cannot be overlooked, if you remember that it takes part in all the processes of life, and that it is required wherever there

is any living action to be performed, or any living thing to be maintained in its vigour and readiness for work. We cannot explain its action. We find it impossible to tell how it is that this simple living matter is able to perform this kind of work. But we know that so it is, and that it is only where these bioplasts are in activity that life continues. If it were possible to cut them off from their supplies, of course they would die. Or if we could kill them, then, though supplies were given, these supplies could not be assimilated; growth, development, and action would cease. All life depends on the action of these bioplasts in transforming the nutrient materials with which they are daily supplied, first into bioplasts, and then into formed tissue.

Muscular tissue differs markedly from connective tissue. We find in the muscles a great many fibres running in definite directions. These directions are determined by the position which the muscle occupies and the use to which it is to be applied. Many muscles, in addition to this arrangement of fibres in the line of action, have these fibres marked by what are called "striæ;" that is, they are crossed by lines that give them a *striped* appearance. It has been noted that muscles under the control of the will are thus striped or crossed, while muscles not under such control have simply the parallel fibres without any such transverse marking. There is, however, one im-

portant exception. We find that the muscular tissue of the heart is striped or crossed, although we are unable to control its working by voluntary effort as we control the striped muscles that move the arms or legs.

The precise meaning of these stripes in voluntary muscles has not yet been ascertained. The function of muscular tissue is well known, and its action can be stated in a very few words. The muscle that is required for bringing any part of the body into position contracts; that is to say, its fibres become shortened and broadened. We consequently speak of muscular tissue as possessing the property of "contractility." It is able to move in the two directions I have indicated, and this shortening and broadening of the fibres bring together such parts of the body as we desire thus to approximate. This power belongs to the muscular fibre wherever we find it, and it is communicated to it somehow or other by these bioplasts of which I have spoken.

When we examine nervous tissue, we find that it presents two appearances. Some portions are reddish-grey, such as the outer layer forming the convolutions or foldings of the brain; while other portions are white, such as the inner part of the same brain, and the cords, or nerves proper, that connect the centres with the circumference. These two kinds of nervous matter form, however, one whole system, which is adapted for

the reception and transmission of various sorts of messages. I cannot enter into a discussion either of the muscular system or the nervous mechanism at this stage. I am talking merely about the marked peculiarities that belong to these different parts, and wishing to draw your attention to the formation of them as depending on this action of bioplasm or living material. In the muscular system we have the power of contracting, and in the nervous system the power of receiving messages from, and conveying messages to, the different parts of the body. These two are sufficiently distinct, and they are also sufficiently separable from the connective tissue.

In order to give a little fuller explanation of one of these tissues, I have before me here two preparations of bone. I have not prepared them myself, so that I cannot tell whether they correspond to my requirements. But I asked that one of the bones might be calcined, so that the gelatinous matter—the animal matter—might be burnt up, and only the earthy matter left behind. If this has been properly done, the bone breaks easily right across. (Breaks the bone.) You cannot thus break the bone in which you have animal matter and earthy matter properly mixed. As we get older our bones have more earthy matter deposited, and consequently become more fragile or liable to be broken. Young bones are more likely to bend. This other bone has been steeped in hydrochloric or muri-

atic acid, in order that the earthy matter might be dissolved, and the gelatinous or animal matter alone left, which is so soft that if we have the bone properly prepared we can actually tie it into a knot (tying it), the earthy matter, which gives hardness, being entirely removed. In young children we have one-fourth of earthy matter and three-fourths of animal matter; in adults we have four-fifths of earthy matter; in old age we have seven-eighths. That represents the pliability and frangibility of the bone in each case respectively.

Now all this is accomplished, this adaptation of structural connective tissue for the different ages and for its different purposes and requirements, by the action of these bioplasts, these structureless, formless particles of jelly-like substances that we find existing in the body. We have a representation of them, as many of you know, in the amœba. As we examine this simple organism under the microscope, we notice that it sometimes shoots out what we would call a finger, technically called a *process;* sometimes it shoots out five or six of such processes. We notice also that it assumes irregular shapes, and moves from one point to another. It is able to lay hold of the nutrient material in the surrounding liquid; and when it has served its own purposes, and taken from it what it wants, it simply disconnects itself from the remainder, and floats away. In that condition it grows and multiplies. We find a similar action performed by these bioplasts within the body.

They are thus able to avail themselves of the materials that are supplied to them, and to form from them the various animal tissues. What a variety we find of these tissues when we examine the body throughout—tissues devoted to different purposes, and subserving a great many ends, and tissues in all variety of circumstances. The skin, for instance, in the palm of the hand becomes hardened in those that perform much manual labour, and thus becomes a protection to other delicate tissues lying beneath. The soles of the feet in like circumstances become hardened. This is particularly noticeable in the case of the Arabs who traverse sandy deserts: and we find a special provision made in the feet of the camel, fitting this animal, without inconvenience, for its long and toilsome journeys over the burning sands. So that, when it is needed, these tissues are not only adapted for the performance of their more general functions; they are furthermore fitted in exceptional circumstances to meet the necessities of individual life.

And all this fitness, general and special, is secured by the action of these bioplasts! And you cannot distinguish the bioplasts that form muscle from the bioplasts that form nerve; you cannot distinguish the bioplasts that form bones from the bioplasts that form skin or muscle. They are all identical in every ascertainable characteristic. Yet these jelly-like particles possess these wonderful capacities and energies, and

are competent to build up and maintain all the different parts of the body throughout our whole life. Nay, more than that, they seem to have what I may venture metaphorically to call their own individual instincts and capacities. For if we take from the film that covers the bone (periosteum) and that is concerned with its nourishment—if we take a fragment of this and graft it on the skin, by a special process with which physiologists are acquainted, we find that this little bit of bone-nourishing bioplasm begins to make bone where we have placed it. It forms osseous tissue on the skin to which we have transplanted it. And each of these bioplasms acccording to its own functions, whether it forms connective tissue, or nervous tissue, or muscular tissue, carries on its own work definitely, and also transmits to its successor the same faculties which we find it to possess.

Let us return for a moment to the statement about the three substances in the body. We have this *living material* between the other two—the nourishing material and the tissue that is being formed. This living material *must* take up the nutriment before it can be converted into formed tissue. And it becomes in its turn, or rather forms in its turn, tissue that is to be used in the body, giving place to other non-living material that it has somehow impregnated with its own life; thus continuing the process, and making provision for a definite continuance without intermission.

I need not say that when we come to these facts we

are in the presence of unsolved mysteries. We can say nothing whatever concerning the secret of this action. We cannot determine in the slightest degree the inscrutable powers in operation here. And for any one to attempt to teach us, in the presence of these facts, that there is not a something that may fitly be called "life," and which distinguishes organisms from the whole of nature besides, I think is to insult our understanding. But our friends who are acquainted with physiology do not attempt to make any such statements. Professor Huxley, in his celebrated lecture on the "Physical Basis of Life," denying that there is any essential difference between dead and living protoplasm, as I understand the lecture, tells us notwithstanding, that the one *becomes* the other "by subtle influences," or the one *is* the other "under modified conditions." Well, what difference is there between speaking of "subtle influences" and speaking of "life"? or between "modified conditions" and "the living"? We have been accustomed to say "A" and "B" in regard to these facts; he wants us to say "X" and "Y." But that is not moving the matter a single step forward. He knows as we do that there is mystery insoluble. We find that there are "subtle influences," "modified conditions," or more correctly "life," a particular thing that we do not find elsewhere, and that makes the whole organic kingdom separable through out all time from the inorganic.

III.

PREPARATION OF ALIMENT.

HOMER tells us that when Ulysses had gone to the war, during his prolonged absence and her supposed widowhood, Penelope was entreated by many suitors to enter into a new alliance. Wearied by their importunities, she at last promised that she would think of marriage when she had finished a fabric on which she was then engaged. Faithful to the memory of her beloved husband, she carefully unwound during the night all that she had formed during the day, so that her weaving made no progress during the many years that she waited patiently for her husband's return.

That is precisely what takes place in the human body. We are continually destroying what we have carefully built up. There is a process of destruction and of renewal continually maintained within the frame. In early life, as you are aware, there is a certain very appreciable amount of gain made within the body. It reminds one of a story that is told of a good squire in the country, who, during a time of

prolonged solitude, sought to while away the weary hours by reading the *Vicar of Wakefield.* He was a very slow reader at any time, and his rule was to read *ten* pages each day, carefully placing a mark in the book at the point which he had reached. A roguish niece who was in the house watched him take up the book daily; and as he laid it down she shifted the mark back *eight* pages. When he had finished—for he did make progress at the rate of two pages a day—she asked him how he liked the book. "It is very good indeed," he said; "but there are a great many repetitions in it!"

During early life we do make progress, but our progress is like the squire's reading, slow and repetitive. In the process of decay and renewal we make a slight advance, gaining somewhat each time, until we reach what is called the period of maturity. I cannot speak a word, or lift a finger, or move a step, probably I cannot even think a thought, without wasting part of the body; and there must be new material continually supplied to compensate for what is wasted. This new material is furnished in the food that we introduce into the body two or three times a day.

You must not suppose, however, that we can represent the actual arrangement of these materials within the body by any analysis of the food that we supply. For you have listened to these lectures to very little purpose indeed if you have not reached this conclu-

sion—a conclusion, as I think, that is warranted by all the facts—that matter within the body is in a very different condition from that in which it exists without the body. Organised material is certainly not to be compared in all respects to inorganic material. Nevertheless, there is a certain ratio, definite and clear enough, that can be stated, if you please, in chemical terms, between the food that we consume and the amount both of tissue formed and of work done consequent upon the introduction of that food into the body.

I have to speak to-night of the preparation from food materials of this aliment which the organism assimilates and uses. I am not going to enter upon questions either as to the amount of tissue formed or energy expended. Suffice it to say that there is a definite proportion between the food-stuffs and the organic products. My present purpose is simply to talk to you about the nature of the process whereby the food is fitted for taking its part in the structure and service of the body.

Several years ago a very interesting, and in some respects a very instructive, division of food was suggested by an eminent chemist, the late Baron Liebig. He proposed that we should divide all foods into two classes, the nitrogenous and the non-nitrogenous; that is, foods that contained nitrogen as one of the elements in their composition, and foods that did not

contain nitrogen.[1] He spoke of the one class—the nitrogenous — as tissue-building, and of the other—the non-nitrogenous—as heat-giving. Now if it were possible to verify this division within the sphere of animal life, it would certainly be a very simple and a very valuable one. Unfortunately, however, we find that many so-called tissue-forming foods are used in yielding heat, and many of the so-called heat-giving foods are used in forming tissue. So that this descriptive division is not an accurate one. It is very difficult indeed to find any such distinctions that can be relied on throughout. But I suppose we may fairly (regarding foods only chemically) speak of those that contain nitrogen, and those that do not contain nitrogen, without adding any theory about their tissue-forming or heat-giving properties.

We find that the non-nitrogenous foods are mainly composed of these three elements: carbon, hydrogen, and oxygen. Looking at them more closely, we find that we can divide them still further. There are some in which hydrogen and oxygen are united in the same quantities in which they ordinarily form water. Starch, dextrine, and sugar represent these. There are others in which the hydrogen and oxygen are united in proportions, in which hydrogen is in excess of the quantity required to form water. These are represented by fats and oils.

[1] Liebig's *Familiar Letters on Chemistry.*

This difference determines somewhat the method of their assimilation within the organism. Let me say here that no chemistry that we are acquainted with can give us full and accurate information concerning what goes on within the body. No processes that we can conduct in the laboratory are in all respects similar to the vital processes that are carried on within the body. And we can gain quite as reliable information —I venture to say much more reliable information—from our observation of the effects produced by different foods, than we can by any analysis of their contents, or inferences founded on that analysis, as to the probable uses to which they may be applied. In other words, our knowledge must really be to a great extent empirical. In fact, we must find out the value of foods by observing the effects that follow the administration of them. We cannot tell beforehand; we cannot prophesy or predict with certainty, from the knowledge that we gain by analysis, what particular purposes, in all respects at least, different foods will serve within the body. But we can tell with considerable accuracy, from a long series of *experiments* and *observation*, the results that are most likely to be reached by the use of different articles of diet.

For the present I make no further reference to these analyses, experiments, or observations. I hope to have an opportunity later on of directing your

attention to some of these questions when I come to speak of food and appetite.[1] My object now is simply to show, so far as I can, what is the process that takes place when the different materials that we take as food are being prepared to take their final place within the body, and to aid in the performance of its functions. Let us endeavour to trace the history of the morsel we put into our mouth from that stage onwards, until we find it ready to assume a definite place in the organism.

On examining the body we find that the reduction of food is accomplished in its passage through a long, irregularly shaped tube, which may be said to begin at the mouth and to end at the lower part of the torso, or trunk. The lining of this tube is an inner skin called mucous membrane, which is continuous with the outer skin, so that, strictly speaking, so long as the food remains in this tube, it has not been received into the body proper, or been applied to its uses.

As I have said, this tube or canal is irregularly shaped—its form and dimensions vary at different stages. In the mouth it begins as a dome-like cavity. Then from the back part of this cavity down to the upper end of the stomach there is a long narrow tube called the œsophagus, or meat-pipe. The stomach itself is a larger cavity, of a shape that is almost universally familiar, fairly represented by the wind-bag of the bag-

[1] See *Health Studies*, Lecture I.

pipes. It is to be remembered, however, that, like the bag with which it is compared, the size and shape of the stomach is subject to variation. Sometimes it is very full, and sometimes it is very empty. When empty it is flaccid, and occupies very little room. From the lower or exit end of the stomach we find another tube or canal arising, which, at first of small calibre and disposed in a coil-like fashion, is known as the smaller intestine; but thereafter becoming wider, first ascending then crossing transversely, and afterwards descending to end in the terminal outlet, it is known as the larger intestine.

This intestinal tube is a very long one—thirty feet or more in length. In round numbers it may be said to be *six times* the length of the body. In some animals, vegetable-feeders, like the sheep, this tube is twenty-eight times the length of the body! In carnivorous animals it is very much shorter than in men. The question has been sometimes raised whether the length of our intestinal canal determines our position as vegetarians or flesh-eaters, and it has been deemed satisfactory to affirm that the medium dimension of the canal proves that we are equally fitted to assimilate both kinds of food.

I am not prepared, however, when the question is thus limited, to accept that as a correct answer. If I am not like the one or the other in this particular structure, it does not follow that I am like both. I

may be designed for some other dietary altogether different from that of the one or the other. It might fairly be argued, for instance, that proper food may be neither grass nor flesh, but fruits and farinacea.

The whole tube in which the food is subjected to the process of reduction, whereby it is adapted for nutrition, is sometimes called, appropriately enough, the *alimentary* canal. For some months after birth this tube is very simple, and its various parts are only gradually differentiated. There is at first no proper stomach for the digestion of ordinary food, and the one diet to which infants should be rigidly confined is that which has been prepared for them—the milk of the mother.

Even at the risk of anticipating what I shall have to explain afterwards, I must state at this stage that all the food we take must be liquefied. It must be fitted to flow throughout the body. Not only must it so flow, but it must be so charactered as a liquid that it shall easily pass through animal membranes. Without going into details, allow me to say that liquids of a certain character pass freely through animal membranes, while there are others that cannot so pass. And all the material that we take into the body must not only be liquid, but also in this condition which will enable it to pass freely through the animal membranes—such as the walls of the vessels in which it may be contained—to supply the need of the bioplasts

for the accomplishment of their particular work. In order to secure this peculiar liquidness we have mechanical and chemical processes conducted within the body. I take for granted that you remember that these inner processes are VITAL. We have no such thing as inorganic chemistry within the sphere of organic life. This thing or state which we call "life" modifies all the actions with which we are at present concerned.

When I would use food in any form, the first thing I do, of course, is to take it by the hand, or by an instrument which the hand grasps, and to put it into the mouth in convenient quantity. May I remind you that there are some animals that do not so act? The cow, for instance, introduces the grass to its mouth by its tongue. The horse introduces its food mainly by the lips. In these animals the lips and tongue are what hands are to us. The squirrel, while using its forepaws in feeding, does not take up the nut in the palm of the paw; it balances the nut carefully on the back of its two paws, inclined downwards and inwards, and so secures the kernel.

There are marked differences among animals in the prehension of food. But we may pass these by and suppose that, having divided the food somewhat carefully, so as to take just a sufficient amount to be acted upon, we introduce it into the mouth, to undergo there the first change in the process of digestion.

And may I say here that it is very important, especially if our teeth in these unfortunate times are not so good as they ought to be, that we divide the food carefully before we put it into the mouth. The mouth is a mill, intended for dividing the food, and we find in it several millstones of different shapes. There are millstones for cutting, millstones for tearing, and millstones for grinding. These three kinds of teeth Blumenbach named from their situation, front teeth, corner teeth, and back teeth, and these terms may be accepted as in common use. We have in all, as you know, thirty-two teeth, sixteen in either jaw; and these are admirably fitted for the work of comminuting the different kinds of food that are suited to the nourishment of the body. When we examine the teeth of animals we find them to be accurately adapted to their necessities; we discover definite relations between them and the other parts of the alimentary canal; they accord thoroughly with their purpose and habits. The teeth are fitted for doing preliminary work which ought to be done for the animal's health and well-being; and by means of the teeth we can form a very good idea, not only as to the kind of food that different animals live on, but also as to their mode of life and general condition. In the human being, as I have said, these teeth are admirably adapted to deal with the different kinds of food that we are in the habit of using. But in civilised life we actually begin

digestion outside the body. We do that by boiling or roasting—by the application of heat in some form or other, for the purpose of making the food more palatable and digestible. It must be confessed, however, that some cooks so change wholesome food that it ceases to be either pleasant or profitable. Do not forget that we have to reduce the food to a liquid condition; any action, therefore, that makes the different parts of the food more easily separable, that breaks it up to any extent, before it is introduced into the body, may aid materially in facilitating this process of digestion. Only let it be remembered, and remembered as a caution, that all the different organs of the body grow stronger and more vigorous by exercise. If we exercise any function within certain limits, that function becomes freer and fuller in its play. So the teeth, the stomach, the glands of the stomach, &c., that are employed in the work of digestion are strengthened by being exercised. And if we digest our food too much before we take it, and reduce it always to pulp so as to give little opportunity for the action of the digestive organs, we may weaken their aptitude, and lessen to a very appreciable extent their available power. If the digestive organs have become inactive or faulty, we may fairly spare them by subjecting the food to some equivalent action before taking it; but in ordinary circumstances they should be expected and allowed to perform their own work. We are able

to some extent to facilitate the process of digestion by culinary skill, and it is needful, often amply, to have recourse to this, in order that we may assist weak digestion. There are conditions of the body in which the digestive process is not carried on very vigorously, and it may be desirable to give food in the most thoroughly digestible condition before it enters even into the cavity of the mouth. Cooking, however, should only prepare the food for natural action, and should interfere as little as possible with such functions as we ourselves are able to perform.

Properly speaking, digestion begins as soon as the food is introduced into the upper end of the alimentary canal; that is to say, as soon as it enters the mouth. It is important that the food should be detained some little time in the lobby. Opportunity will thus be afforded to ascertain its character, and to prepare for its worthy reception. And particularly if the food be in the form of bread-stuff, or other material containing starch, it ought to remain in the mouth a certain time that it may be thoroughly mixed with the *saliva*, which is secreted or prepared by special glands. There are three of these glands: one near the ear, called the *parotid;* another under the jaw, called the *submaxillary;* and another under the tongue, called the *sublingual.* They pour out a quantity of saliva, which is mixed with the food, moistening dry food, and acting specially upon the starchy elements, converting them into a

substance adapted for reception into the tissues of the body. Starch has to be changed into sugar before it can be thus received;[1] and this change is, at least to some extent, effected by the action of the saliva. On the whole, I am inclined myself, so far as my teeth will allow me, to prefer starch in the form of biscuit, because when we take it in that form we are obliged to keep it in the mouth for some time while it is being ground down, and thus a full opportunity is afforded for what has been termed its *insalivation*. If any of you take a biscuit and chew it deliberately, you will find that it becomes sensibly sweeter, because the starch it contains is undergoing this change. This process of digestion, in which the starchy materials are altered, begins in the mouth. If we swallow food quickly, before we allow it to be thoroughly comminuted or broken up, we burden the stomach with more work than falls to its proper share—in fact, we spare the teeth at the expense of the stomach; and besides overtasking the stomach, the breaking-up omitted in the mouth may not be fully accomplished later on, and the whole process may be thus marred and made imperfect. We ought to give the food the full benefit of this preliminary detention for these two reasons I have stated—that it may be broken up as far as possible by the action of the teeth, and that the

[1] Strictly speaking, it is changed first into dextrine, then into

starchy material may be acted upon by the saliva before the food goes further.

Let us suppose, then, that the food has been properly broken up and mixed in the mouth. The mass, or, as it is sometimes called, the *bolus* is moved back into the throat by the action of the tongue, and it is there grasped and passed on by the muscular tissue of the meat-pipe, or œsophagus, into the stomach. Those who are acquainted with the anatomy of the parts know that the breathing-tube lies in front of the meat-pipe. If by any mischance a fragment of food or a drop of water finds its way into the wind-pipe, we suffer considerable annoyance, and immediate spasmodic efforts are made for its expulsion. There is an arrangement of a very neat kind—if you will allow that word—to prevent this miscarriage. I may also add that the breathing-tube has an opening into the nostrils. There is provision made in the upper part of the throat for closing that entrance to the nostrils, and there is provision made at the same time for closing the entrance into the wind-pipe while the food is being carried into its own proper receptacle. Let the space between the forefinger and thumb represent the entrance to the wind-pipe, while the tube down which the food is to pass lies behind the forefinger; the food in its passage backwards closes the valve which protects the opening of the wind-pipe, just as we close the opening between the thumb and fore-

finger by pushing the thumb back upon the forefinger.

When food is introduced into the meat-pipe it does not fall down simply according to the law of gravity. If material be thrown into an upright iron tube, open from the top to the bottom, of course it would fall down by the action of this law. But this meat-tube, as I have said, grasps and pushes the food downward. We find a circular band of muscular fibres along the whole length of the tube, and these so act, when stimulated by the presence of the food, as to squeeze it onward and downward. It is pressed down in this way as if I were gradually to squeeze onward a mass enclosed in an indiarubber tube. This kind of action, which we find also in the intestines at the other end of the alimentary canal, on account of its worm-like progression, is often spoken of as vermicular. You can observe this process if you look at a horse in the act of drinking. You notice that the horse's mouth is down much lower than the upper part of the throat, and the water that is drank must be carried up against the law of gravitation. If you look carefully you will see something like a ball pass along the throat as each gulp is taken. The constricting muscles are forcing each mouthful of water upward and onward into the stomach. Jugglers, because of this arrangement, are able to astonish the ignorant by drinking a glass of water while standing on their head.

When the food has reached the stomach, what action takes place there? We have learned already that digestion *begins in the mouth*, and I wish you now to note that it *does not end in the stomach.* Although a very special process is conducted there, the food is not prepared to enter into the circulation even when that process has been completed. Nay, after it has left the alimentary canal, it is not prepared even then to enter into the circulation. Part of it passes through the liver, and all of it has to pass through the lungs, where it receives oxygen from the inbreathed air; but to this latter action I do not ask your attention now, because it will come more naturally before us when we study the *circulation* of aliment.

What takes place, then, in the stomach? As I have explained already, the stomach is shaped, when it is fairly distended, something like the wind-bag of the bagpipes. At the upper end, lying to the left side of the body, we find the entrance to the stomach, where the food received from the mouth enters through the meat-pipe; at the lower end, lying to the right, a little beyond the middle line of the body, we have the outlet where the food, after due preparation, passes into the duodenum,[1] the next part of the alimentary canal.

The food in the stomach has to be "dissolved" (I do not know a better word) to some extent. If I

[1] This term is derived from a Latin word meaning twelve, because it is about twelve fingers' breadth in length.

were to put a lump of sugar in a glass of water, and leave it for some time, the lump would disappear though the sugar would remain, and I would say that the sugar had been dissolved in the water. If I were to put a piece of beef or mutton into the glass of water and leave it for hours or days, it would not dissolve or disappear, because the water has not the power of so acting on meat. Now the bread and meat that we take have to be dissolved; they have to be liquefied so that they may be carried throughout the whole organism. And this liquefaction [1] has to be accomplished during the process of digestion, and a very important approach to it is undoubtedly made within the stomach. We have three different tissues in the structure of the stomach. There is the outer part (serous membrane or tissue), to which we need not pay much attention now, which allows it freedom and ease of motion. We have next to that the muscular tissue, to which I will call your attention presently, and within, the mucous coat or tissue lining the whole cavity. You will understand what mucous tissue is when I tell you that the inner skin of the lips is mucous tissue or membrane. In this mucous tissue we have a great many little glands—great masses (when I say great I am speaking of their number rather than their size, for they are really

[1] Of course there are other changes effected on the food besides making it thus transportable.

microscopic), great bundles of little vessels crowded together for the performance of certain work. These glands [1] get their material from the blood, and form or secrete a peculiar fluid called stomach-juice. It is called *gastric juice* in scientific treatises; but that title is derived from a Greek word (*gaster*) meaning "stomach," so that really it is only stomach-juice after all. We can analyse it and discover what it contains.

At this stage it may very properly be asked, how is it that we know anything of what takes place within the stomach? It so happens that we have gained a great deal of information in regard to the stomach's action from observations and experiments made in the case of a young Canadian who was, I think in 1822, the subject of an accident which left a very convenient opening into that important organ, the stomach. A gun was discharged within a yard or so of his body, and some of the shots were lodged for a time in his abdomen. Part of the abdominal wall in front was carried away and an opening made into the stomach. He did not die, but recovered under careful treatment, and I believe is living still—at least he was a year or two ago. He was under the care of Dr. Beaumont, a most intelligent and painstaking observer, who con-

[1] "Glans" is the Latin word for acorn; and these *little masses* of vessels are called glands because of a fanciful resemblance to acorns.

ducted for seven months a series of well-arranged and valuable experiments for the purpose of ascertaining the nature and characteristics of stomachal digestion. A full account of his observations and experiments has been published in an interesting volume.[1] A great many other experiments have been made on animals by vivisection. But these are subject to the objection that we cannot predicate that precisely the same processes take place in human beings; and further, where you cause such disturbance of the nervous system by the infliction of pain you produce other results that may vitiate your experiments. I do not wish to go out of my way to say anything in regard to vivisection, but it is a rather suggestive fact that the information gained by vivisection is frequently conflicting and sometimes contradictory.

In the case, however, that I have mentioned we have a great amount of information conveyed to us in regard to the operations of the stomach and of the gastric juice that is thoroughly reliable. Both the facts that have been observed and the conclusions that have been based on these experiments are generally accepted by physiologists. You will find a very interesting and readable account of Dr. Beaumont's investigations in Dr. Andrew Combe's *Physiology of Digestion*, a most valuable book, though written a good

[1] Beaumont's *Experiments and Observations on the Gastric Juice.* Boston: 1834.

many years ago.[1] I remember reading it, I do not choose to say how many years ago, and I have at this moment a distinct remembrance of the pleasure I derived from its perusal. Well, we learn from these observations and experiments made by Dr. Beaumont what takes place within the stomach. We know that the food when its enters that organ is made to traverse the whole cavity from left to right, returning again from right to left. It takes a little time to make this circuit, and by means of the muscular tissue which we found in its structure this action is maintained regularly during the process of digestion, so that the food is continually being sent round from one end to the other. While it is making this circuit the gastric glands are pouring out great quantities of stomach-juice, which is thus brought into contact with the different parts of the surface that are successively exposed. As the food travels round the stomach and is thus acted on it is partially dissolved, and this pulp, or as it is called in books, *chyme*, is carried on to the exit end of the stomach, where it is allowed to pass out if found to be sufficiently prepared. By this action of the gastric juice on the external part of the mass we have successive new surfaces exposed and pulpified until the whole mass

[1] *The Physiology of Digestion Considered with Relation to the Principles of Dietetics.* By Andrew Combe, M.D. Recent editions bring the information up to date.

has been reduced to the right condition. We cannot by any mechanical means stir the food in the stomach ; but this organ, by means of its muscular fibres which send its contents rotating from one end to the other, contrives most effectually both to stir round these contents and to mix them intimately with the fluid which it secretes. That fluid, the stomach-juice, has the power of dissolving or acting upon, to a certain extent at least, certain materials it finds in the food. There are some materials on which it exercises no power. It does not change the starchy parts or the fatty parts, but the muscular parts, such as the lean of meat, it softens and separates. It dissolves the connective tissue, which, you remember, is the part that binds all together, and in that way the muscular fibres are easily separated and disintegrated prior to their entering into the blood. Indeed, the stomach, by an organic process which is nevertheless both mechanical and chemical, prepares the food for becoming blood. It does what might to some extent be done by heat; but it does this at a comparatively low temperature. The temperature of the stomach is somewhere about 100°, and of course we cannot boil meat except at a temperature of 212°. So that, although a similar result is reached, we are not entitled to say that the process of digestion is a physical one. In this way it acts on the fibrous parts of the food, breaking them up and preparing them for

entering in solution into the blood. The stomach-juice acts chemically on what are called albuminous substances. These substances are of the same character and composition as the white of egg, which may be regarded as typical albumen. This white of egg and its allies are not readily soluble in water, do not pass through animal membranes, and are coagulated by heat. After submission to the action of this fluid in the stomach, the character of these albuminous substances in these respects is reversed; and they are thus thoroughly adapted for assimilation and serviceableness in the body. In this new and *digested* condition they are called *peptones*. The organic principle in gastric juice which acts after this fashion is called "*pepsine*."[1]

In order that the stomach may do its work effectively there must be a sufficient supply of gastric juice forthcoming to act upon the materials that have to be altered. I have no doubt that some will think that I am exaggerating when I say that the amount of gastric juice that is formed in the stomach in the course of a day has been estimated, with considerable accuracy, at fourteen pounds. Indeed, we form also about two pounds of saliva daily within the mouth; and I was somewhat amused the other day, when thinking over this subject, to find, as my attention was called to it, that I became subject to a rather excessive mouth-watering. Probably my attention

[1] Pepsine, from the Greek word *pepto*, which means to cook.

being directed to these salivary glands had excited them to rather more vigorous action than usual. Yet this large amount of saliva, and this much larger amount of gastric juice secreted in the body, are not in any sense wasted; the whole quantity of both enters into combination with the food and is received into the organism, and is afterwards, in its elements at least, available for the very same purposes that it has been employed to subserve already. It flows in a shut circuit, and these two pounds of saliva and fourteen pounds of gastric juice,—like a score of supernumeraries on the stage, who may be so repeated by a skilful manager as to represent an army several hundreds strong,—might presumably, if there were no waste, do duty over and over again.

Still there must be for the digestion of the food within the stomach healthy action on the part of these gastric glands. Dr. Beaumont observed the circumstances in which they were excited, and he tells us that the introduction of any substance into the stomach awakens their activity. When they are busy at work, a great many glistening drops form and gradually flow down the inner lining membrane of the stomach in little rills. When the action was vigorous and healthy, the fluid thus formed could act effectively on suitable substances. But many causes may arrest the action or alter the secretion of these glands; for instance, fear, anger, anxiety, and other mental affections seem

to exercise a very marked influence on the whole process.

I ask your attention to this fact, because nowadays we are frequently reminded that the body acts on the mind, and it is well to remember sometimes that the mind acts also upon the body. And we find that when the mind is excited or harassed this stomach-juice is either lessened in amount or altered in character, so that it is found insufficient for the digestion of the food. This weakness of function is indicated by loss of appetite and relish for food. Nevertheless, it is notorious that when the desire for food is wanting, some officious friends are sure to insist on the necessity of food consumption. They are anxious to pour food into the stomach at all hazards. But the stomach is a better guide in these cases than any officious friend can possibly be, and where it refuses to welcome food that refusal may be taken as a sure indication that it is useless and vain to place food within it. When people are weak from illness, their friends are often anxious that they should eat a great deal. And I am willing to admit that they would recover more quickly if they could assimilate easily large quantities of nutritious food. But when they are not able, even thus far, *to digest it*, excess of food forced into the stomach only acts as an irritant, and gives rise to more distress and weakness than they would otherwise have to endure. I

believe, if we paid more attention to what we may fairly call the voice of nature, we should be healthier and stronger than we are. We can only digest a certain amount, and the amount we can digest is the amount that is available practically for the body's use. Any excess of any kind is wasted, and, moreover, it hinders and mars the digestive functions of the stomach. In cases where the stomach is so weak that it cannot digest, it is very important to give the food in such a condition as to require almost no stomachal digestion. It has been found practically in some cases, such as the weakness of typhus fever, that the best food we can give is childhood's food—milk. Professor Gairdner, of Glasgow, proved this brilliantly by treating thus a large number of fever patients in the Royal Infirmary of that city, the number of recoveries secured being largely in advance of those attainable by other treatment. Previously it was customary to give wine freely to fever patients who seemed in danger of sinking from loss of strength. The milk treatment beat the old wine treatment out and out, and there has been a marked change in practice ever since.

All food must be properly prepared in the stomach before it is allowed to pass the outlet, called the *pylorus*, from a Greek word meaning "gate-keeper." There are certain muscular fibres that constrict, in a valve-like manner, this outlet, and these fibres only expand or relax to allow the food to pass out of the

stomach when it has been properly digested there. When the food has undergone this appropriate change, it is called chyme, and when the chyme comes to this "gate-keeper" in a pulpy or sufficiently reduced state, it at once allows it to pass; but "rude undigested masses" are turned ignominiously back. By-and-by, when they have come a great many times, and the "gate-keeper" finds that the stomach can make nothing of them, it allows them to go, so to speak, under protest, in the hope that something may be done with them elsewhere. There are some matters that cannot be digested anywhere, such as the woody fibre in certain vegetables. These pass on through the whole length of the intestinal tube, and are thrown out unchanged.

Food remains in the stomach ordinarily between two and four hours.[1] I do not think we should put fresh food into the stomach until the former meal, if it has been a fair one—or, as our American friends would say, a "square" one—has had time to get on far enough to leave that organ free to begin work again without any drawbacks or arrears.

When the chyme has passed into the first portion of the intestine, called, as you remember, the duodenum, it is mixed there with other two fluids—one supplied by the liver, and the other by the pancreas,

[1] The time varies according to the "solubility" or "digestibility" of the substances composing the meal.

or sweetbread. The liver is not merely a secreting organ; it is, to a large extent, an excreting organ also, withdrawing from the blood certain materials of which it is necessary to get rid. To that filtering function we give no attention at present. Let us note, however, that it forms a special product called "bile," which is of a reddish-yellow colour, and is the principal agent in the digestion of fats. It enters into combination with the fatty constituents of the food, sometimes forming emulsions, and sometimes forming soap-like substances. There are in the liver a great many bile-making glands congregated together in masses. Lying on the liver, and having open communication with it by a duct, there is a reservoir called the gall-bladder, in which a certain quantity of bile is stored up ready for use. Part of the bile is apparently intended to be thrown out as waste; it passes away with the undigested parts of the food, and indeed assists indirectly in their removal. I ought to say further that the bile seems to act in a somewhat strange way by arresting and altering the digestion of the peptones.[1] I am inclined to ask whether the bile may not be thus used in correcting any excess of action that may have taken place within the stomach, neutralising any over-result of gastric digestion. However, that is a question for

[1] Nitrogenous substances that have been prepared for absorption by the action of the gastric juice are called "peptones."

further inquiry. The great use of the bile, so far as we know at present, is partly to emulsify the fats, and to make them soap-like that they may be in a proper state for ultimate assimilation.

The pancreatic juice is similar to the saliva, and acts upon the materials that are subjected to it after the same fashion. It changes the starch that may be found in the duodenum, and which has not been sufficiently acted upon in the mouth, into a soluble sugar, so that it may pass easily through animal membranes to its place of service in the body. We find also that there is thrown out from the intestine itself a certain amount of what is called intestinal juice, which seems to be in quality a weaker kind of the other juices that we have found already supplied; so that if any particle has escaped solution, the intestinal juice may take up and complete the task.

The food is detained a considerable time in the smaller intestines. These form a long, continuous tube (about twenty-five feet in length), and are arranged in a coil-like manner in the lower part of the abdomen, evidently for economy of space. They furnish accommodation for a very large amount of material. Besides, they have certain expansions called *valvulæ conniventes* (helping-folds), that increase their superficial area very much, so that they allow a very wide spread-out of their contents.

From this extensive area the materials that have

been formed through digestion in the mouth, stomach, and intestines are sucked up by little leech-like vessels called lacteals, and carried into the thoracic duct, from which they are transferred to one of the veins, and emptied into the heart. From the heart they are sent into the lungs, where, being mixed with air, their transformation into blood is complete.

I ought to say, in regard to these helping-folds (*valvulæ conniventes*), that they are of great use in enlarging the area of the intestines. By these windings and turnings a very large amount of surface is contained within a narrow compass.

There is a story told about an Englishman and a Scotchman, who were disputing about the relative excellences of their respective countries. The Englishman maintained that his country was superior to Scotland, and, of course, my countryman maintained the opposite. They argued the question, *pro* and *con*, at considerable length. At last the Englishman said, "You must admit that in one respect England is superior to Scotland—it is larger." "I do not know that," replied the other; "because, you see, in Scotland we have a great many high hills, and if they were beaten out flat, like the plains of England, you would find that perhaps Scotland was much the larger after all." Well, these helping-folds are like the mountains, because of the larger surface which they expose; they detain the chyle a longer time, and allow all the nutri-

tive material to be extracted by these little lacteals, so that we have all the gold extracted from the ore and transmitted to the minting chamber, where it is duly stamped and passed into the currency.

IV.

CONVEYANCE OF ALIMENT.

MILITARY strategists have learned the importance of supplying their armies with food. It is not sufficient that they have some communication with the place where food may be obtained; they must secure its conveyance freely and amply to the combatants. They know that if they can surround a city or camp so as to cut off the supply of nutriment, surrender is only a question of time. And they know as well that if they are removed from their own base of supplies, so that they cannot feed their combatants sufficiently, these combatants will not long continue in a fit frame for fighting.

It is not enough that we have production; we must have conveyance of material. I hear it sometimes said that wealth depends entirely on the produce of the soil, and the producer is credited as the creator of wealth. It seems to me that in society as at present constituted wealth depends as really upon those who are engaged in the interchange of material as upon those who are engaged in its production. Commerce

is advantageous to the body politic no less than agriculture, and our lives would be very limited and very poor were it not for the wide ramifications in which the exchange of commodities enriches the peoples of the world.

I do not dilate on this, although it is a tempting subject. My present purpose is simply to speak to you concerning the conveyance of aliment within that wondrous though narrow organism, the human body. Will you be surprised to learn that water is the medium by means of which this conveyance is secured? If I were to cut off the river Thames below London Bridge, so that no vessels could come up to the city; if I were also to destroy the railway lines round about London, so that no trains could run in; and if I were likewise to block up the roads, so that no waggons could reach our streets, we would be starved within a few weeks. It is not enough that there be plenty in the world, or in the empire; the plenty must be brought to our towns and to our homes that it may be made available for us as individuals.

Now what these various modes of conveyance are to cities, that, and more, water is to the human body. It floats all the solid nourishment of the frame to the various parts of it where that nourishment is required. When I examine the body I find that water forms by far the largest amount of its bulk and of its weight. A body weighing 165lbs. will contain about 110lbs. of

water; so that water forms about two-thirds of the whole. If we were entirely to dry the body—to drive off all the water it contains—it would become very light indeed.[1] The most solid structures of the body have water in them, otherwise they would cease to live. We have water in the bones, no less than in the flesh.[2] We find water abounding everywhere throughout the body. And although it may have other uses—on which it is not my purpose to dilate—its main use is to serve in conveying all the different materials that are needed to each individual tissue and territory of the human frame. Nothing can serve this purpose except water. You may get it in various combinations — pleasantly flavoured in fruits, and sometimes very unpleasantly flavoured in rivers, and sometimes very injuriously associated with alcohol. But it is the *water* that is serviceable wherever we find it; and water is good, no matter though it be in bad company. It is the water that people imbibe in drinking beer that alone serves this useful purpose in their frames. It is sometimes said that total abstainers are great water drinkers; but I venture to say that they drink less water than those who use strong drink. The users of spirituous liquids must consume a considerable proportion of water. There is no man alive

[1] Blumenbach had a mummy which weighed only 7½lbs.

[2] In bone, water forms about 22 per cent.; in muscle and brain, about 75 per cent.; in connective tissue, about 79 per cent.; and in the vitreous humour of the eye, about 97 per cent.

bold enough or foolish enough to consume pure, absolute alcohol. Water to dilute and sheathe it must be taken along with this poisonous substance; and in most instances the water very largely preponderates. Besides, the use of alcohol engenders a thirst that calls for larger and still larger supplies of the "limpid element;" whereas those who are in the habit of keeping their blood cool [1] and free from such ingredients are not tormented by this raging desire for fluids. I do not think that I drink much more than a gallon of water in the year, *as water.* Of course I take tea; sometimes, though very rarely, coffee; and very frequently milk, which I regard as one of the best forms of liquid food that we can take. And when we take water in tea, coffee, soups, &c., the water has been, or ought to have been, boiled, and any organic impurities that it may contain are thus likely to be destroyed. Pure cold water seldom passes my lips, not because I despise it, but because I feel no desire for it. I am very fond of fruits. They suit my palate; and I find in them a very large quantity of water very pleasantly flavoured by a natural process. And let me say here that those things that are pleasant

[1] "I am strong and lusty;
For in my youth I never did apply
Hot and rebellious liquors in my blood;
Therefore my age is as a lusty winter,
Frosty, but kindly."

As You Like It, Act ii. Sc. ii.

to us are *generally* good for us. We were taught somewhat differently when we were boys and girls, perhaps to save the contents of the sugar-basin. We were solemnly informed of dangers to teeth and stomach in the consumption of sweets. But negroes in the cane-fields who eat large quantities of sugar do not spoil their teeth or stomachs in doing so. The things that are sweet and pleasant to the unsophisticated palate, and that our natural appetite desires, instead of being bad for us are commonly good for us. You may take that as a safe general rule. Animals follow it, and we are animals in our material structure, and we do well to follow our instincts in this direction even as they do. Of course we are *reasoning* animals, and I must add that these instincts are consequently to be followed within *rational* limits.

Water, then, plays this important part in the organism. It is the *medium of conveyance* by which the different materials are brought to the several places where they are required. Water enters largely into the composition of our food; and there are very few kinds of food—I am not sure that I can name one—in which we do not find a notable amount of water. We call bread "dry," but it contains a very noteworthy amount of water. If we take a slice of bread and, putting it on a toasting fork, hold it before the fire, we find that steam escapes from its surface; that is, as we know, the water it contains is evaporated

by the heat. We find water in the fibre of cotton wool. We do not, of course, use that as a nutriment, but I mention it as an illustration of the fact that water is to be found in certain places where we would not expect to discover it. I may say, I think safely, that all the food we are in the habit of using contains more or less of this element—water. It has even been said by some—though I am not prepared to accept their doctrine—that we ought never to drink water in its free condition; that we ought to take it in its natural combinations, in fruits, farinacea, &c.; and that in this way the wants of our bodies can be freely and best supplied.

However, as we have found that water enters into the composition of our food, so we find it in those substances within the body that act on the food. We find it giving flow and penetration to the saliva; we find it likewise bringing the active principle of the gastric juice to bear upon the contents of the stomach; we find it in the bile, and in all the juices and secretions of the body.

In a former lecture we followed the food from its entrance into the mouth to its reception into the thoracic duct—a vessel not thicker than a common goose-quill, which runs up in front of the backbone, beginning near the upper part of the intestines and running up to the region of the heart. This canal empties its contents—called "chyle," and received

from the lacteals, or little leech-like vessels, that dip into the intestines and suck up their contents—into the superior *vena cava*, or hollow vein, which conveys them into the right *auricle*, or right receptacle of the heart. At the same time that the chyle comes into this superior vein it is mingled with a very large amount of fluid matter that is poured also into the same receptacle.

I have not yet spoken of another series of vessels that we find in the human body, called "lymphatics" —vessels that take up waste materials and carry them by a circulation of their own from all parts of the body, emptying them at last into this same superior hollow vein, by which they too are conveyed to the upper right side of the heart. Now we have to learn here that the blood that is being formed, the fresh chylous material that has been produced by the digestion of the food, and the waste material—shall we call it "the sewage of the body"?—are mixed together and carried, in one current, into this right receptacle of the heart. I do not think we have anything like that in our cosmical engineering. We have these elements mixed intimately together, preparatory to the process of conveyance of aliment throughout the system—the waste material and the new material that is to take part subsequently in the process of living.

The heart, as you are aware, is a double organ. It is divided in the centre by what is called the septum,

or division, into two sides, a right side and a left side. And each of these sides is divided into two chambers, an upper and a lower. That is not so in all animals. There are some animals that have no heart at all. I do not mean that metaphorically, but literally. And there are others that have only one heart—not a double heart, as we have. Again, I do not mean to use these terms metaphorically, but literally. Fishes, for instance, have only a single heart, and consequently a single circulation. But in man we find a double heart and a double circulation. We have the sides—the right and the left—and we have corresponding to these two sides two circulations—a circulation through the lungs and a circulation through the whole body. One is called the pulmonary or lung circulation, and the other is called the systemic circulation, or circulation throughout the whole system.[1] Any one could tell readily enough, having that information, which side of the heart is the stronger. Of course, the one that has the larger amount of work to do. The right side is the side employed in what I have called the lesser circulation; the left side is the side employed in the larger circulation. I have said that there are two chambers—an upper and a lower—in each side of the heart.

[1] Perhaps it may help the memory to think of the heart as a two-floored house, with two reception-rooms in the upper floor and two work-rooms in the owera.

These two chambers are called respectively, in both divisions, the auricle, or receiver, and the ventricle, or discharger. One takes in and the other gives out. I am dwelling on this, speaking somewhat slowly, because I am anxious that you should apprehend readily, as I think you may by even a very slight attention to this matter, the nature of the construction of the organ which is the fountain of the whole circulatory system. May I repeat in a sentence, so that there may be no mistake, that the heart is double: one side—the right—being employed in the circulation through the lungs; the other side—the left—being employed in the circulation through the whole body. On both sides there is a receiver and a discharger, an inlet and an outlet. I prefer calling the one a receiver and the other a discharger, because, in the latter case particularly, the word suggests the employment of force in sending forth the blood on its different journeys.

Well, we find this *vena cava*, as it is called, emptying its contents into the upper right side of the heart. These contents are, at the same time, as soon as received, passed from the upper into the lower chamber. Then the contents are forcibly expelled by this right ventricle or discharging chamber into the *pulmonary artery*, the canal in which they are carried to the lungs. I ask your attention for a moment to the name given to these vessels, one of which goes to each lung. Ordinarily we speak of the arteries as containing one kind

of blood, and of the veins as containing another kind. We find two kinds of blood in the body—a bright red or vermilion-coloured blood, commonly called arterial; and a dark, purplish, almost black blood, called venous blood. These two kinds of blood are so called because they are found in the arteries and veins respectively. *In the pulmonary arteries we find dark venous blood*, the very opposite of that which we find in other arteries. In this instance an artery carries venous blood. But then, please to note, it carries blood *from* the heart, and *that* is the distinctive characteristic of arteries. Arteries, in *anatomical* language, are those vessels that carry blood *from* the heart, no matter what may be the colour or character of the blood they contain. Veins are those vessels that carry blood *to* the heart, no matter what may be the colour or character of the blood.

Within this artery carrying the dark blood there is the chyle; the waste material brought back by the lymphatics; and the return blood supply received from the veins. It has been said truly that in this one current flowing from the right side of the heart into the lungs you find the blood of the past, of the present, and of the future.

Please to observe, that we are not yet done with the preparation of the aliment, though now we are following its circulation. In the very beginning of its progress we find the blood undergoing a further

change. This may be considered an intermediate stage—partly preparation, partly conveyance.

The lungs, into which the blood is carried, are peculiarly constructed. We have descending from the back part of the throat, and in communication with the nostrils, the trachea, or windpipe, which, branching off to the right and to the left, divides into two tubes called the bronchi, or bronchial tubes, one of which enters each lung. These tubes, on entering the lung, give off a great many distinct branches. These again ramify into an innumerable multitude of twigs that occupy the whole extent of the lungs. Then, on the other hand, the pulmonary artery, of which I have spoken, when it reaches the lung gives off a similar number of branches, and these are divided and subdivided after the same fashion; these minute vessels, reassembling and enlarging in reverse order to form what is called the pulmonary vein, in which the changed and purified blood is to be returned to the heart, and this circuit of vessels occupies also the extent of the lung. If it were possible to dissect out the air communication—the bronchial tube, with all its branches—we should have a bush-like mass representing the size and shape of the lung; and if it were possible, on the other hand, to dissect out the pulmonary vessels, with all their branches, we should have a similar bush-like mass. And these two, the air-tubes and the blood-vessels, are throughout

conterminous. The air-tubes end in lobules or little berry-like cavities, in which the capillaries or hair-like vessels come in contact with the enclosed air. The lung itself may be compared to a big sponge. Suppose we take a piece of the lung-tissue distended with air and put it into water—it floats, because, with the contained air, it is lighter than water. This is one of the methods that medical men use for ascertaining, in cases of supposed infanticide, whether the child has breathed after its birth or whether it has been still-born.[1]

These vessels from the heart, getting into all parts of the sponge—allow me to use that term as a helpful one—convey the mass of blood into it that they have brought from the right ventricle of the heart. And there the blood meets with the air brought in through the nostrils. You notice I say the nostrils, but I do not mean to say that is the right word in all cases. Because, unfortunately, a great many people breathe through the mouth rather than through the nostrils. But the nostrils, and not the mouth, are intended for breathing. And one reason I have for calling your attention to this fact is that, if we breathe through the mouth, the air is not properly warmed before it comes into contact with the delicate tissue lining the bronchial tubes. I think oftentimes colds and coughs are caught by an unguarded opening of the mouth, especially on

[1] Taylor's *Medical Jurisprudence*, p. 434, 7th edition.

going out of heated rooms into the cold winter atmosphere. I make it an invariable rule to keep my mouth shut after going out of a heated room, and by doing so I have had a wonderful facility in escaping colds and coughs. Always when possible we should breathe through the nostrils. We should acquire this habit so thoroughly that during sleep breathing shall go on easily and unconsciously with the mouth closed. The nostrils are intended for breathing. The air is warmed in the chambers of the nostrils sufficiently before it reaches the delicate membranes, and it is not deprived in any degree of its valuable qualities. It enters the wind-pipe and bronchial tubes as pure, but not quite so cold.

Well, the air coming into the lung is carried by the tubes into the lobules, or berry like cavities, where it meets with the blood. But you may tell me the blood is contained in vessels, and the air is contained in these cavities, and there is no opening between them; how do the two come in contact with each other? It is not true, as some have thought, that blood, poured out anyhow, nourishes the body. Nor is it true that air brought in anyhow, is fitted to accomplish its work in the body. If blood is thrown out from the vessels (extravasated) under the skin, it does not nourish; it must in that case be removed. Instead of being a nutrient material it is a waste material that the body must get rid of. It can only

nourish when it is contained in shut vessels. And from these shut vessels the particular elements in it that are requisite are going out after a special fashion of their own. I am going to use two big words, but I hope you will understand their meaning before I am done with them. They are *endosmosis* and *exosmosis*. They are quite as easily understood as protoplasm or bioplasm. Suppose I take a bladder, which is an animal membrane, containing, say, a solution of salt, and dip it into another vessel containing a like solution of salt, there is no interchange between the two solutions. But if I take this bladder, or animal membrane, containing the solution of salt, and put it into a vessel containing water, I find that the water in the vessel becomes saline, and that the solution in the bladder becomes weaker. Some of the elements in the bladder pass out into the vessel, and some of the elements in the vessel pass into the bladder. There is a going out and a coming in — *exosmosis*, going out, or pushing out, to give the correct rendering; and *endosmosis*, a pushing in. Where we have liquids of different densities, we find that there is this interchange of their contents through animal membranes. The blood being different in density from the other fluids with which it comes in contact, the animal membrane or capillary in which the blood is contained allows some of its contents to pass freely through; and, on the other hand, some of the fluids

with which it is surrounded pass freely in. There is a going out, or pushing out, and a pushing in.

Now let me tell you what is done in the capillaries. Harvey, as you are aware, discovered the circulation of the blood. There can be no doubt whatever of that. A great deal was known and accepted on this subject before his time; but to him belongs the honour of having made it perfectly clear, and of having established it in such a way that it has been, to a very great extent, the beginning of true physiology. Michael Servetus undoubtedly knew a great deal and suggested more. You will find it stated in some books on this subject that Calvin roasted Servetus and his books, and in that way delayed the discovery of the circulation of the blood. Now, believe me, Calvin did nothing of the kind. He held certain doctrines which Servetus denied, and it was the custom in those days for the parties that could control the secular power to burn heretics. We have got rid of all that wicked nonsense. But all parties alike held that miserable doctrine in Calvin's time, and probably Servetus would have consented to Calvin's death as readily as Calvin consented to his. They were all equally mistaken on this particular subject, and I do not vindicate one side or the other. But to say that Calvin exhibited any special malice or malignity, as is implied in the accusation that he "roasted Servetus," is certainly to make an assertion which the facts of history do not warrant.

Harvey, however, did not demonstrate this circulation in the capillaries; he seems rather to have thought that the blood flowed chiefly through pores from the small arteries into the small veins.[1] In that case, would there not be an irrigation of the body by blood similar to the irrigation of earth by water? Four years after Harvey's death, Malpighi demonstrated by the microscope what we know as capillary circulation. We know now that the blood circulates in shut vessels from first to last. It comes from the heart contained in vessels, and it goes back to the heart contained in vessels. There is no breach of the continuity, no "solution" of the continuity, as our surgical friends would say, throughou[illegible] is within shut vessels from its going out to its r[illegible]

Now, in these little vessels in the [illegible] blood is brought into contact with the air tha[illegible] pire. For we have to learn further, that as there [illegible] e an interchange of liquids of different dens[illegible]s through an animal membrane, so there may be *interchange of gases;* and it is this interchange of gases that takes place in the lungs. You remember that the blood as it flows into the lungs contains both the new supply sent from the stomach and the old supply transmitted by the veins. In that old supply there are waste substances that have been taken up in the circulation, and among these there is a certain amount of *carbonic*

[1] Da Costa's *Harvey and his Discovery*, p. 51.

acid gas. We take in, as we breathe, a large amount of atmospheric air. We do not give out in return the whole gaseous contents of the lung; that is to say, we do not empty the lung, nor do we inflate the lung completely at each inspiration. There is always a reserve stock, so to speak, in the lung. We take in, as I have said, a large amount of atmospheric air. You know that air is composed of two gases, nitrogen and oxygen. So far as we know at present, nitrogen seems mainly to be used as a diluent; that is, to limit the amount of oxygen, and consequently to lessen the action there would be if it were breathed alone.

Oxygen is the one element in atmospheric air that, so far as we know, is employed within the body in doing work. We take in this oxygen into the lungs, where it comes into contact with all these small capillaries in which the blood is contained. The carbonic acid gas contained in these capillaries passes out through the membrane, and the oxygen inspired passes in. The carbonic acid gas escapes into the air cavities, and the oxygen makes its way into the blood-vessels. The oxygen thus gets into the blood, and is carried from the lung to the heart, thence to be sent on its travels throughout the whole body; while the carbonic acid gas, which is thrown out in the lung, passes out into the atmosphere by the return breath, or expiration.

We get rid, in this way, not merely of the carbonic

acid gas, but of other things as well. For, let me remind you of what I said in the last course of lectures, that there are other materials passing off in the breath.

We give off water, which you find deposited on the walls of rooms within which a great many people are breathing, or which you may find collecting on the sides of a glass into which you breathe for a few moments. We also give off certain waste animal matters. And these substances are substances of which we ought to be rid. Now is it not common sense that if these various materials, carbonic acid gas, &c., ought not to continue in my body, they ought not to be received into yours? And if I breathe them out, you should not breathe them in. If they are bad for me, they are not good for you, therefore you should not inhale them. That is the whole secret on one side of the value of ventilation. We must have these foul products removed; and, on the other side, we must have the element of oxygen freely supplied.

We have thus endeavoured to learn how the carbonic acid gas is removed from the body, and how oxygen is introduced. In consequence of this exchange of old for new—waste material for vitalising oxygen—we notice that the blood, which as it came from the right side of the heart into the lung was dark or purplish black, goes back to the left side in a bright vermilion-coloured stream. And this change in colour is mainly due, so far as we can ascertain, to this intro-

duction of oxygen and dismissal of carbonic acid gas.

It is a very interesting question, in what form does this oxygen exist in the blood, and how is it carried along in the current? So far as can be determined, we find that it is carried by means of little discs, commonly called the *red corpuscles* (little bodies) of the blood. These are very small; we cannot see them with the naked eye. They may be described as something like half-sovereigns in shape; in a drop of blood under the microscope, we may see little masses of them lying together like rouleaux of coin. They are so small that it would take 3,000 touching at their edges to form an inch in length, and 12,000 placed one above the other to form an inch in height. Yet it is by them, apparently, that the oxygen is transmitted in the circulation, and they are, on this account, sometimes called oxygen-carriers.

Perhaps you are not prepared for this fact, that this oxygen, which is so often called the life-giving element, is mainly used in the destruction of the body. Yet without it we cannot live for five minutes! I can live without food—well, perhaps two weeks, or even more. That depends entirely on the fatness of the individual and other circumstances. There is a story told about a fat pig having been imprisoned for a long time by the fall of a chalk cliff under which it had been feeding. At the end of its long-continued

enforced abstinence, when rescued, it was as thin as a whipping-post. It had been living on its own fat to the great loss of its owner. It had literally been devouring itself; thus lessening considerably its commercial value. Different people can live a longer or a shorter time without food, according to circumstances. But we may live, at all events, for several days without food. I suppose we could live without water for three, perhaps, or even four, days; but we cannot live without oxygen for more than three or four minutes! If you put a man's head under water for five minutes, he will never lift it again himself; that will have to be done for him. Five minutes of this immersion would be quite sufficient to kill the strongest of us. I believe that there are some cases in which people have been immersed a longer time and have been recovered. I think I have seen it somewhere asserted—it is a very interesting statement, but I cannot recall at this moment my authority—that there have been cases in which persons have been immersed for a considerable time and recovered. And this explanation has been suggested; that these were probably timid, weakly people, and the suddenness of the danger had caused fainting, and consequently all the processes of life being brought almost to a standstill, they could for a longer time than usual dispense with the aid of oxygen. For the correctness of this opinion I am not prepared to vouch; but, at all events,

it affords sufficient reason for long-continued efforts to recover people apparently drowned, even though they may have been immersed for a long time, a time more than sufficient, as we may think, to cause death.

Now is it not strange that this element, without which we cannot exist for five minutes, is mainly employed in carrying on the work of destruction? Oxygen within and without the body is actively engaged in changing all substances that it can affect. The oxygen entering into combination with the tallow, for instance, the candle gives out flame and heat. The oxygen entering into the body from without, seizes on certain of its constituents which it disintegrates or breaks up, producing what Liebig calls *eremacausis,* or a slow combustion, in which heat and force are evolved. You will not wonder very much at this, when I remind you that it is by this wasting of the body that the available heat and force are produced. When we remember that a certain amount of force is needed for the maintenance of life, for breathing, for digestion, and for all the different functions that are performed in the body, as well as for all the different actions performed by the body, and that this force is gained by expenditure of substance—we can understand the value of oxygen the destroyer; for this destruction is actually the process of living, just as the burning of coal is the production of heat. Oxygen is to certain contents of the organism, in a very

precise sense, what it is to fuel. It is not enough that I have coals in the grate. If I do not supply the combustible material with atmospheric air, the fire will be extinguished in a short time. The draught or supply of air is as essential to the continuance of the flame as the fuel that is supplied. In the same way we must have oxygen carried into the body in order that its work may be done, that its heat and force may be sustained without intermission. And it is circulated, as I have said, by means of these little red corpuscles, which carry it to every part of the body where there is work for it to do.

There is one fact of some importance that has been established, I think, beyond contradiction, in connection with this, namely, that these red discs or corpuscles are very much altered by the imbibition of large quantities of alcohol. It has been ascertained that they are shrivelled and shrunk, and in many cases broken up altogether in the case of those who are in the habit of using large quantities of alcoholic liquor. And this may be one of the reasons—I believe there are many—why alcohol, which seems so useful in maintaining heat outside the body, fails to raise the temperature within it. If I put alcohol into a spirit-lamp, I get a strong heat. If I put it into my own body, I lower the flame of life instead of heightening it. We know that by the thermometer; it is not in dispute at all. By placing the thermometer under the

tongue, we can ascertain the temperature of the body. We know that in ordinary circumstances its temperature is about 98°. If we take two or three glasses of brandy, and, after sufficient time has been allowed for diffusion, introduce the thermometer again, we find the heat has sensibly decreased. Instead of the body being raised in temperature by the introduction of alcohol, it has been lowered in temperature. May this not be one reason? Although it might be useful as fuel, it damps the flame by lessening the amount of oxygen, in diminishing the carrying power of the blood corpuscles. At all events, it can be proved that, instead of making us either stronger or warmer, it measurably makes us weaker and colder.

I am quite aware of this fact: if any one feels chilly, and is suffering from the effects of a lowered temperature, a glass or two of grog warms him at once; he feels a great deal more comfortable after he has taken the liquid than before. I am quite prepared to hear any one who has made the experiment say, "That seems to contradict your explanation." Well, now, let us look at the fact; for I admit it to be a fact, and I have a great dislike to breaking my head against facts. Suppose I take a glass of brandy. Any of you watching my face would notice that my cheeks become flushed, showing that the blood begins to course more freely through them. Unfortunately, I am not a good subject for this experiment, because

my cheeks are not very pale at any time; but there are some in whom this is wonderfully illustrated very frequently. At all events, when we take alcohol in this form into the body it increases, in some way or other, the flow of blood to the surface.

There is another fact, which I have not told you, and which I must state now in order that you may understand this result. We have in the circulation two currents. We will say an up-line and a down-line, the goods coming by the up-line and the empties being sent back by the down-line. We have supplies of nutriment carried to the city by the up-line and then we have the waggons sent down with returns of some kind, or sometimes empty, to bring us further supplies. In the same way the heart is continually sending out the nourishing blood that it has received from the lungs, sending it through the body by the arterial circulation, and receiving it back by the down-traffic through the veins. We have these two lines, and just as in the railway system we have, in connection with the traffic, special telegraphic wires that are employed to regulate the traffic, so we have along with the circulation special telegraphic wires, or nerves, to regulate the supply of nutriment. One of these is associated with every vessel, large or small. We have little twigs going out to regulate the contents of these vessels, so that they are adapted to the necessities of the traffic as direction may be given. These nerves

employed in this way can be acted upon by certain substances, and we know definitely that alcohol is exceedingly powerful as a paralyser or deadener of nerve action. When we introduce alcohol into the body, it somehow acts on these nerves that are in connection with these blood-vessels. These nerves act on the vessels which are under the skin of the cheek, for instance, retaining them in a certain state of tension or tightness, only allowing a definite quantity of blood to pass. The alcohol deadens the nerve and paralyses this power, so that they no longer keep the vessels thus tightened, and in consequence they are relaxed and open more freely. In other words, there is a larger and freer supply of blood allowed to pass into the small vessels under the transparent skin of the cheek than there was before. You have no more force applied to the heart. People used to say that alcohol made the heart beat more strongly. It makes it beat quicker by taking off, as I have explained, the restraint on the flow; not by giving force, but by arresting the action of the nerves that tighten the small vessels. The red blood freely courses under the transparent skin, and the increase in the current is seen in the flushing of the face. The warm blood being in that way sent out freely to the exposed surface of the skin, of course I feel warmer. I am externally heated by the warm flow of blood over the surface of the body; but what takes place afterwards? The cold air meets

the warm blood thus thrown to the surface. It is a provision of nature that when I am exposed to cold, in the first instance the blood is sent in from the surface, in order to maintain the heat of the body. I reverse the process, and send the warm blood out to the surface and expose it to the cold air by means of this action of the alcohol.

Suppose I am travelling on a very cold night in winter by an express train. We come to a station. I notice that the refreshment-room is open, and I rush in to get a cup of hot coffee. When it is brought to me I find that it is almost boiling, and that I cannot drink it without scalding my lips. The guard rings the bell; the train is ready to start, and I have no time to lose. I want to take as much of the warm coffee as I can, but unfortunately it is so hot that I cannot drink it. What am I to do? I pour it out of the cup into the saucer, back into the cup, and back again into the saucer half a dozen times, and then it is cool enough for me to drink. I have thus exposed the contents of the cup to the surrounding cold air, which has taken up a large measure of the heat, and made them drinkable. So when the blood is sent to the surface, giving indeed a temporary superficial warmth, the cold air carries away a certain amount of the heat, and the blood is sent back chilled and lowered in temperature into the inner part of the body, and when I think I am made warmer I am in reality made colder.

I find that I have not finished my subject, but I have finished my time. Well, we have the blood conveyed from the lungs, containing this oxygen, to the left side of the heart. In the left side of the heart it is received in the upper chamber, and is sent from that down into the lower chamber. In the heart we have provision made so that the blood passing from one chamber to another does not return. We have different kinds of valves that prevent the regurgitation or flowing back of the blood, between the two chambers on each side of the heart. We have them also in openings into the large vessels leading out of the heart. Coming into this lower chamber of the left ventricle, it is sent by a strong impulse into the aorta, the large blood-vessel springing from the heart, which, forming an arch, gives off branches to the head and arms, and then descending into the lower part of the body it bifurcates or divides into two large branches, one of which goes to each of the lower limbs. Each of these branches divides and subdivides until they become hair-like or capillary; and then these capillaries form larger and still larger vessels called veins, in which the blood is carried back again to the heart. I have thus given a short outline of the course of the circulation.

Now we do not know much about the forces that keep up the circulation. At all events, I do not think physiologists have come to any conclusion that is not

at least open to dispute. There can be no doubt that the impulse of the heart has a great deal to do with the circulation. So far as we know, mainly, if not altogether, this impulse is the cause of the circulation. But there are some who do not accept this statement. They imagine that there must be other forces at work. At all events, we know that that impulse is sufficient to circulate the blood in the vessels during the greater part of their course. The arteries themselves are elastic and also contractile, so that when the heart sends the blood out into the aorta, it is urged onward in a wave-like manner. Consequently, if an artery is cut the blood comes out in jets. This is a recognisable distinction between wounding an artery and wounding a vein. The blood oozes out from a vein in a more or less sluggish manner. Wounding an artery is a dangerous thing, because the flow of blood from an artery is not easily arrested; the blood flows with such force that there is no pause for coagulation or thickening. When blood is exposed to the air for a short time it coagulates—that is, it separates into two portions, one solid, the other fluid. The bleeding stops when the blood clots; the clot forms a natural plug and stops up the end of the vessels, but that cannot take place in such vessels as arteries when the blood is jetting forth freely. When they are injured in this way the blood spurts forth with considerable force; but if a surgeon is called in, he can lay hold of the mouth of

the vessel and tie it, and in that way stop the bleeding. When the artery is tied the upper part sends out branches, and a curious anastomosis (forming of a new network) takes place, and new branches are made, so that the nourishment is carried on as before, and there is no harm done.

In this way the blood is conveyed by the arteries right on until it comes to the capillaries, and from these it is taken up by our old friends the bioplasts, in order that they may perform their task in forming tissue. Then when these tissues are broken up, as they are by the oxygen, the waste material is carried back partly by the veins, and partly by the lymphatics I have spoken of, and returned to the upper right side of the heart, along with the chyle that is brought from the intestines: whence the process is repeated over and over again.

At any one time we have about ten pounds of blood in the body, and in the course of a year more than three thousand pounds of blood pass through the system. In one sentence, I may sum up the story of the circulation.

The blood is sent from the *right* side of the heart into the lungs, and is returned to the *left* side of the heart; from thence it is sent by the arteries throughout the whole organism, these arteries ending in the capillaries in which the minute distribution is effected; the blood left in the capillaries is assembled in the

veins, by which it is restored again to the left side of the heart; and from the heart the current sets forth continuously so long as life lasts.

V.

REMOVAL OF WASTE AND NOXIOUS PRODUCTS.

IN the case of a man weighing 140 lbs., we find that he introduces into his body, in the course of one day of twenty-four hours, upwards of 7 lbs. of substance. During the same time he excretes or removes from his body 7 lbs. of substance. For it is quite evident that, were it not for this removal, the body would grow exceedingly in weight and in bulk. Why, in the course of twenty days he would add as many pounds to his body as he originally possessed! So that we have the balance maintained, so long as we remain the same, between what we call the *ingesta*—the things taken in; and the *excreta*—the things given out. Within certain limits it is possible that a man may increase somewhat both in size and in shape; but even though he does reach the proportions of a Daniel Lambert, with a weight of 20 to 25 stones, he finds that he at last reaches a limit beyond which it is impossible for him to proceed. We may introduce into the body a very large amount of material, but beyond a certain amount we are unable to make any

profitable use of it within the body. I am speaking now of adult life. Of course, in childhood and youth there is a certain amount of increase available for purposes of growth and development.

Now, of the amount that we take daily, these 7 lbs. —no less than somewhere about 5 lbs., rather more than 5 lbs., I should say nearer 6 lbs.—are made up of two elements—one drawn from the air, and the other from the clouds and the springs. Oxygen and water form nearly 6 lbs. weight out of the entire amount. And when we come to the excreta we find that water and carbonic acid gas together form in like measure a very large amount of that which is thrown off.

We have already found, in following the course of the blood, that in the lungs a very large amount of oxygen is taken in; and we have incidentally noticed that a large amount of carbonic acid gas is thrown off. We have to attend to-night rather to the latter fact than to the former. In the liver, too, we have already found that bile is produced, which is largely used, so far as we can determine, in the preparation of certain elements for ultimate absorption or assimilation into the body. We have now to learn in addition that the liver exercises another function, concerning which we have not yet reached very definite knowledge. We know that part of the bile, at least, is used in the removal of the waste materials from the

lower end of the alimentary canal. Then we shall find further that the kidneys, situated near the spinal column, in front of the lumbar region, are employed in removing certain waste or noxious products from the blood, and preparing them to be discharged from the body. Then we shall discover, in addition, that the skin, while it has other and very important functions, largely serves the purpose of an excretory organ, and gives off water and carbonic acid gas mainly, in definite quantities. Indeed, we find also that any of these organs may act as a substitute for any of the others to a very remarkable extent. We should not think, for instance, of the skin, as having anything to do with the function of breathing; yet you may remove the lungs from a frog, and it will continue to live for a considerable time by the respiratory action of the skin. In that animal the skin can perform vicariously the function of the lung, and serve to maintain the animal in existence for some time.

All these organs are employed in removing what I have called, "Waste and Noxious Products." Perhaps we may sum them all up in one term, "noxious." For when we have done with them — when they have served their purposes—they become hurtful and injurious if allowed to remain. We must get rid of them in some way or other, and by the functions which these different parts of the body perform we have them removed readily and freely as required.

Perhaps I had better begin by talking particularly of the work done by the liver. It is one of the largest organs in the body, and is situated on the right side, below the right lung, and extending partly over the upper part of the stomach, immediately under the diaphragm or midriff. We have it divided into two parts, or lobes; and when we examine it minutely, we find it is composed of a great many little lobes or lobules, and that its structure fits it marvellously for accomplishing what may be roughly termed a process of vital filtration. It is provided with a pear-shaped reservoir, called the gall-bladder, in which it stores up for ready use the *bile*, which, as everybody knows, is the name given to the fluid it secretes. This reservoir lies under the liver towards the lower right extremity of that organ. The liver itself forms and gives off, as it is needed, its own peculiar secretion; but it has also this storehouse into which it pours a reserve supply that may be drawn upon for special purposes.

I have said that the liver has another function, in addition to that which I am speaking of as the removal of waste and noxious products. Some of the contents of the liver are thrown into the intestines—into the upper portion, the duodenum—to take part in preparing the food for its assimilation. We have already noticed [1] that particular action of the bile, and

[1] See Lecture III., p. 73.

I do not need to go back upon it. Some of it, however, remains in combination with the excrementitious or unassimilable parts of the food, and is carried onwards and downwards into other parts of the intestine; and there it seems to act as a stimulus to the action of the lower part of the alimentary canal, and to aid in the expulsion of what has been called by Liebig, I think fairly, "the soot of the furnace." We are apt to think that the waste matter of the alimentary canal constitutes by far the largest amount of the waste products of the body. It is not so in any sense whatever. It is a very small part indeed, and yet it is needful that it should be regularly removed. As the soot would clog up the chimney and lessen the draught of air, thus hindering the fire from giving forth as much heat as it might otherwise do, so our carelessness about the removal of these unassimilable materials from the alimentary canal may prevent the enjoyment of full life, and the healthy, vigorous action of the whole frame. To some extent, as you are aware, this process is under the control of our own will. The action of the liver in forming bile is not controlled by the will. The action of the kidneys in secreting their product is not under the control of the will. The action of the skin is not under the control of the will. But the final action of removing the waste matter from the alimentary canal is under the control of our will to a very considerable extent. And I believe this is of great importance in

connection with the arrangement fixed for getting rid of these unassimilable materials. I believe we can largely form the habit, and appoint the time whereby and when these waste products may be removed. Allow me to assure you, that it is most important and advantageous that we should form the habit, and maintain it, of allowing these waste materials to be removed at one particular time in each successive day; and that so soon as we have formed this habit we have gained a very valuable power over this action of the alimentary canal. A great many illnesses and inconveniences result in ordinary life from inattention to this fact. There is no condition of the alimentary canal that is more complained of than constipation, and the only effective way to guard against that is by *training* the alimentary canal, in this respect, to do its duty faithfully and regularly. That is, to a much larger extent than most people suppose, fairly within our own power. All the valuable recipes that are frequently urged upon our notice may be summed up in three words—STATED PERIODICAL ATTENTION. If you adopt this hint, you will soon find that stated periodical ACTION will become habitual. And it is a very hurtful practice, a very foolish and mischievous practice, to be having recourse continually to purgative medicines for the performance of this function, which can be managed more healthfully, more easily, and more safely in the way I have indicated.

I do not dwell longer on this subject, because, although it is important, it does not really occupy the same platform of importance on which the other excretory functions stand. Attention is very often given to this action alone, and it is supposed that if we are careful therein we need not be very much concerned about other excretions. That is a very serious mistake. A very few ounces only of waste is removed from the body by this process. By far the larger proportion has to be removed by the kidneys, by the lungs, and by the skin. And our attention must be carefully given to the action of these organs, if we would maintain due proportion, and if we would secure vigorous and enjoyable health.

I may speak next of the excretory function of the lungs. We have already considered the action of the lungs in one specific direction. We have learned that oxygen comes in contact with the blood, and is taken by it and introduced into the current that, coming from the right side of the heart, returns to the left side of that organ and is thence distributed throughout the body. We have now specially to note that this blood coming from the right side of the heart contains a certain amount of carbonic acid gas. This has to be got rid of in the lungs, through the process of which I spoke in my last lecture—the familiar process of breathing. In breathing we perform two acts; we take in something, and we give out something. The

one is no less important than the other. Indeed, it has not been settled up to this moment, whether or not it is more injurious to increase the amount of carbonic acid gas, or to lessen the supply of oxygen. A quotation from a well-known and valuable discussion of physiological questions will best illustrate this statement. "Atmospheric air contains only 21 per cent. of oxygen. But if 50 per cent. of oxygen be mixed with 50 of carbonic acid, a warm-blooded animal is suffocated in it, in spite of there being more than double the amount of oxygen present in the ordinary atmosphere. Bernard, who made the experiment, thinks that the carbonic acid in this mixture prevented the oxygen from entering the blood, not only because of its greater solubility, which gives it a tendency to displace the oxygen, but also because of the obstacle it presents to the exhalation of carbonic acid. On the other hand, the careful and extensive experiments of Regnault and Reiset show that respiration will take place quite well in an atmosphere which contains as much as 23 per cent. of carbonic acid, if at the same time it contains as much as 40 per cent. of oxygen. How are we to reconcile such facts as those just cited? In the one case, we see that 50 per cent. of oxygen is insufficient if the amount of carbonic acid be also 50 per cent.; in another case, we see that 40 per cent. of oxygen suffices, if the carbonic acid do not exceed 23 per cent.: and we would explain both

by saying that, unless the amount of oxygen nearly doubles that of carbonic acid, respiration is impossible, were it not for the irresistible objection that reptiles breathe in an atmosphere which has become charged with carbonic acid, and has gradually lost all but three per cent. of oxygen."[1] At all events we are sure of two things: We require to have a very large supply of oxygen, and we require also to be able to exclude and get rid of the carbonic acid gas freely and fully, if we are to maintain the health of the body. Retaining or breathing this gas is mischievous in a very high degree.

I do not need to enforce, as I have taken occasion to do that already,[2] the importance of taking care that the atmosphere we breathe does not contain a large amount of this carbonic acid gas. I remember well what occurred on Friday, 2nd December, 1848. On that night the steamer *Londonderry* was crossing from Ireland to one of our ports here, with a great many passengers on board. During the transit, the weather became heavy, and the captain afraid that the passengers might suffer inconvenience, and perhaps that some of them might even be washed off the deck by the waves, which were breaking over the bulwarks and paddle-wings, ordered them all below. If I remember rightly, there were about two hundred on board. The

[1] Lewes's *Physiology of Common Life*, vol. i. p. 381.

[2] See *Studies in Life*, p. 160.

steerage passengers were ordered down into a cabin of very small dimensions.[1] After having had them shut up there, and still caring for their comfort, the captain ordered a large tarpaulin to be thrown over the only means of access to the cabin. The consequence was that next morning some seventy or eighty of them were found dead or dying. They were poisoned by confinement in this close atmosphere with its limited supply of oxygen and its steadily increasing enormous excess of carbonic acid. Now it may not be possible for us, with our present knowledge to tell exactly whether the greater mischief resulted from the absence of oxygen, or presence of carbonic acid. But we know that it is important that we should have enough of the health-giving, vital air, and that we should not retain or receive back again the enfeebling, deadly gas.

Some years ago our medical friends spoke out plainly and forcibly, against tight-lacing. Wasp-like waists may seem beautiful to the beholders, but they are certainly not wholesome to the possessors. They tell of lessened vital capacity in the chest. I have no intention, however, of reiterating warnings that are scarcely applicable to young men. My allusion to the subject is only intended to enforce upon you in an emphatic and memorable manner the necessity of allowing free play to the internal organs, and to plead

[1] The cabin was 18 feet long, 11 feet wide, and 7 feet high.

especially at present for the unhindered expansion of the lungs. Please to note that nothing should be allowed to limit their mobility. Indeed the whole trunk should be free, that their action may be unfettered. Restriction or tightness in any part of the body is in ordinary circumstances an evil. And although it may seem to some a trivial thing to call attention to an apparently insignificant detail in dress, yet I do not hesitate to do so, because in my judgment it is not unimportant.

Without presuming to prescribe any particular form of garment, I insist that all garments should fit the body so loosely or easily that all movements may be natural and unrestricted. More mischief results from the neglect of this precaution than, without tedious explanations, I could induce you to believe. But, at all events, you can understand that narrowing of the trunk and preventing freedom of action in any part of the breathing mechanism must, of necessity, interfere with the receipt of oxygen and discharge of carbonic acid.

This is not merely a question of more or less comfort, it is really a question of physical well-being and vigour. When we lessen the capacity or muscular elasticity of the chest, we are restricting our gaseous income and expenditure, just as really as if we were shutting ourselves up within a limited area. Some have larger lungs and some have smaller, and we must

do the best we can with what we have got. But let us not, by any careless or foolish conduct, do anything that would lessen the usefulness and activity of such lungs as we have. Depend upon it, the measure of our efficiency and joyousness will be largely determined by their free and vigorous play.

We may now proceed to consider the action of the kidney. This organ does not remove merely the excess of water that may be present at any time; it separates water, holding in solution a certain salt called *urea*.

This salt is the result of decomposition, and is produced by the wasting action of tissues in which nitrogen forms a leading ingredient. Speaking broadly, the amount of urea excreted may be taken as a measure of muscular waste. I shall not trouble you with any anatomical details of the structure observed in the kidney. Suffice it to say, that it has an outer bark-like substance (cortex) and an inner arrangement of multitudinous little tubes (medulla). The blood, which is conveyed to it by an artery called the renal artery, is submitted to a peculiar process of filtration for the removal of the waste material of which I have spoken. The artery, on entering the kidney, subdivides into a vast number of little hair-like vessels (capillaries), which are again massed in a vein, by which the blood, having parted with some of its contents, is restored to the circulation. We find that

the *vein* in which the blood is returned from the kidney contains the purest blood in the body: there is a marked diminution in the quantity of urea it carries. So far as can be determined, this salt is removed from the blood by a special process called *dialysis*. I shall endeavour, in a few simple words, to indicate the nature of this process. In some cases of sudden and suspicious death, when there is reason to think that poison may have been administered, it is usual to examine the matters contained in the stomach and intestines of the dead body for traces of the suspected poison. Let me suppose that, in a specific case of somewhat suddden death, we have grounds for suspecting that a soluble salt of arsenic has been administered during life. We have submitted to us the whole contents of the stomach—a very miscellaneous, grumous mixture, with which it is not very convenient to deal. Can we, without risk of defeating our object, reduce these contents to a simpler form, in which we can with equal certainty and greater facility prosecute our investigation? The answer to this question has been supplied by a series of interesting experiments conducted by the late Professor Graham. He found that it was possible to separate with great accuracy certain substances that were mixed together in one fluid mass. This separation, which he styled *dialysis*, depends on the fact that animal membranes in contact with fluids allow some

substances to pass through them and do not allow other substances so to pass. Substances readily soluble pass easily, while glue-like substances, commonly termed *colloids*, are scarcely diffusible at all. We take, then, the whole mixture submitted to us, and enclosing it in an animal membrane, such as a bladder, we suspend it in chemically pure water contained in a jar. Within a short time the soluble salt of arsenic, if present, will pass through the membrane into the water, where we can subsequently find it by the application of the usual tests, while the colloids or glue-like substances remain enclosed within the animal membrane.

It is supposed that in some such fashion the kidneys act on the blood that passes through them—that they dialyse the blood, leaving undisturbed the other contents while secreting certain portions of the liquid containing urea and some other substances in solution. This separated fluid is carried by little tubes called ureters into a reservoir known as the bladder, from which it is in due time passed along another tube and expelled from the body.

As I have said, these and other organs employed in removing waste products are to some extent vicarious, so that the liver, for instance, may compensate partially for the sluggishness of the kidney, and the kidney may compensate for the sluggishness of the liver. There is a margin of this substitutional action

by which one organ may relieve another, if that other happen to be inactive or overworked. We have a familiar example of this substitution in the increase of skin-action during warm weather, with corresponding decrease of kidney-action; and the increase of kidney-action during cold weather, with the corresponding decrease of skin-action.

We may, at this stage, pass naturally to a consideration of the skin as an excretory organ. The skin is composed of, and conveniently divided into, two layers—the scarf-skin, the external covering which we touch and see, and which we know to be destitute of sensibility; and the inner or true skin, which is very sensitive. I am not going to talk to-night about the nerves of feeling which have their seat in the skin; the study of them must be deferred until we are prepared to consider the "special senses." I have to speak to-night simply of the excretory functions of the skin. I hardly think that it would be possible to give you any exact idea of the number and arrangement of the tubes that are contained in the skin. Dr. Erasmus Wilson calculates that united they would form twenty-eight miles of tubing. I am not sure that we get any real idea of the action of the skin from an enumeration of these miles; but we have a fair idea of its work and of its importance as an excretory organ when we remember that it removes about two pounds weight of matter daily. The outer,

visible part of the skin is formed of scale-like cells pressed together, and, if we examine it microscopically, we find that as it deepens we reach a point where these bioplasts, of which I have spoken frequently, begin to appear and act. Nails and hairs are simply skin-appendages. They are of the same structure as this outer skin, slightly altered for particular uses. So, too, are the horns of animals. One reason why the true skin has this outer covering or coat of non-sensitive material is evidently that it may be protected. Thereby the inner and particularly sensitive layer is saved from rude contact with the outer world. At the same time, we must confess that there is a slight disadvantage in this covering, and the disadvantage is unnecessarily increased if we allow an excessive amount of these scale-like cells to accumulate. They are literally being continuously produced and thrown out by the living action within, and it is desirable that the old layers should be removed as the fresh layers are formed. If the layers become numerous, not only do we blunt the sensibility of the surface, we also obstruct the action of the excretory glands that are employed in the important task of removing effete and noxious substances. These excretory glands are called the sudoriferous or sweat-producing glands. Associated with them we also find in the skin the sebaceous or oil-glands. These oil-glands produce a substance that keeps the skin flexile,

and which also keeps the hair in a healthy and proper condition. We find them in large proportion in certain parts of the body where they are most wanted, and in other parts they are almost entirely wanting. The sweat-glands we find distributed very fairly over the whole of the body. In some places we find them in larger quantities than in others—for instance, in the palms of the hands and in the soles of the feet; and they are almost entirely absent from the back of the neck. When we examine the substances they secrete or separate, we find them to be water, carbonic acid, and certain salines. These substances are contained in the fluid perspired. Perspiration is recognised under two conditions—sensible or insensible. It is sensible during excessive heat or when we exert ourselves violently; for in these circumstances large sweat-drops stand on our brow or begin to form and flow along our limbs. It is insensible at ordinary times, but no less real; for there is always more or less of this watery exhalation passing from us into the atmosphere in the form of invisible vapour. The dryness or humidity of the atmosphere must, of course, largely affect this transference: dry air inviting it and humid air repelling it. On the importance of fully maintaining this function I need not dilate. If the skin be inactive, then either other organs are burdened or waste matters are retained. In any case, mischievous results are not slow to follow.

In this connection I may call your attention to another purpose served by perspiration. It aids materially in regulating the temperature of the body. In very warm weather, or when we are exposed to a strong artificial heat, the perspiration comes readily to the surface and we are cooled, not as if water were poured over us, but by the gradual evaporation of this fluid that has been thrown out. There is no more effectual method of cooling the surface and reducing its temperature than this. The intense cold produced by evaporation has been used in some instances by dentists to lessen sensibility in the pain of toothache, or to deaden the nerve filaments preparatory to the extraction of a tooth. We can, by evaporation from the surface, lower the temperature of the body very decidedly. And in warm weather, especially during exertion, the perspiration being evaporated by the heat of the air, the temperature of the body is very pleasantly reduced. There is admirable provision made for maintaining its animal temperature equably in many different conditions. In the Equatorial and Arctic regions we find that the human body maintains very nearly the same temperature. In the one case, the temperature of the air is higher than the natural temperature of the body; and in the other case, it is more than 100° lower. Yet in both cases the bodily temperature is maintained at the normal standard. And one of the means whereby this maintenance of

the normal standard is secured in hot climates finds its explanation in the evaporation of the watery products of the sweat-glands.

Now there are some who perspire more freely and readily than others. That may depend to some extent upon individual constitution. It may depend, for instance, on special nervous action. But, in addition to these cases of difference, there is something to be allowed for the condition in which the skin itself is maintained. If we allow the pores or outlets of the sweat-glands to be closed or obstructed by "matter in the wrong place," we must of necessity interfere to some extent with this natural and needful process. There are many evils that result from this carelessness about the condition of the skin, and I will venture to recommend one method of setting it free for the discharge of its duties. Before doing so, permit me again to insist on the importance of this great excretory organ of the body—I call it great advisedly. At the coronation of Pope Leo X. a little child, intended to represent an angel, was covered all over with gold leaf. The child died within the space of a few hours. The skin was hindered from doing its work, and death resulted. In some experiments, animals have been covered over with impervious material, that allowed no action of the skin, and no escape of anything from the surface. They always died within a short time. And this very remarkable fact was noticed—that the

temperature invariably fell. At first one might be disposed to think that it would rather have been raised by covering the skin, when we remember that the outer air with which we are familiar is ordinarily colder than the body. The heat of the body is about 98° to 100°, whereas the outer air in this country is seldom more than 70° or 80°. We put on clothes and coverings of different kinds, not to make us warmer, but to prevent the body from being chilled by the abstraction of the heat which it generates. If I put on some impervious covering so that there is no escape of the heat, one would think I should become warmer, but it has been found that the temperature falls to a very large extent. This fact seems to indicate that the skin has other actions with which as yet we are not acquainted. I believe that it performs other functions that have not hitherto been discovered. Probably it has more numerous relations to the world outside than the wisest among us have yet imagined. At all events, we are sure of this, and we know it from practical experience, that this extensive and important organ should be preserved in thoroughly good working order. It may be pertinently asked here: Ought I to take a cold bath every morning? Yes, if you like it. I do not choose to take one. If individuals find themselves refreshed and invigorated by a cold bath, by all means let them have it; but I do not find that for all constitutions a cold bath is either pleasant or

healthful. There are some of us who cannot benefit by the protracted application of cold water, not because we have any objection to the bracing effects of cold applications, but our power of evolving heat is not sufficient to overcome readily the depressing effects of immersion, even though it be of short duration. There are some people who come out of a cold bath with their fingers bloodless and their teeth acting unpleasantly as castanets; their vitality has been unmistakeably lowered by the reduction of their animal heat, and it is not sufficiently restored even by vigorous rubbing with a dry towel. I think that there has been an exhibition of some foolishness both in the use of cold water and in the praise of cold water; so far, at least, as its application to the body is concerned. Mark you, I am not saying anything against water. I am speaking about the temperature of water. Indeed, you may take a cold bath every morning and yet not keep the skin in a very healthy condition after all. Water alone, especially cold water, does not remove the waste and other material from the skin. If I were to wash my face simply in cold water, I should not look very bright at the end of the week. We use in addition a very valuable preparation called soap (with which, I presume, we are well acquainted), which acts chemically on the substances that ought to be removed and facilitates their removal. And, on the whole, I find it most agreeable and, I think, most

useful, to apply the water at a temperature nearly equal to that of the body itself. We may regulate the temperature very much according to our feelings. Water thus applied to the whole surface once a week or oftener, as circumstances demand, will be found fairly adequate to the maintenance of the skin in a state of healthy activity.

I may mention one other thing, simply by way of addition. In some cases, and especially in some cases of disease—although I am not dealing with disease in this course—it may be advisable to have recourse even to more active measures with the design of exciting the excretory function of the skin more decidedly. For that purpose, I do not know any more valuable agency, *under proper direction and used with due caution*, than what is commonly known as the Turkish bath. I believe the liver is blamed for a great deal of mischief it never does. If people get out of sorts in any way, they are almost sure to say that their liver is out of order. I think that this unfortunate organ gets a very large amount of blame which it does not deserve. The truth is, that what are commonly called bilious complaints are simply cases of indigestion, and could be got rid of most easily, although, perhaps, not most pleasantly, by a little course of starvation. Some people are very much afraid of lessening the amount of food they take. Now, I believe that there are very few indeed who do not regularly eat too much. At

all events, it is very safe, if we are in ordinary health and are suffering from any derangement of the digestive organs, to give them rest. I do not know a more valuable healing agency in such cases than rest. But in any case in which the *liver* is really at fault, when it is either sluggish or imperfect in its action in consequence of being overtasked, the Turkish bath will frequently be found to act wonderfully in giving it relief and enabling it to resume its healthy action.

By means of it, particularly by the profuse perspiration it excites, you can *flush the sewers*, and hurry out stagnant, hurtful deposit. I may add that what is known as the wet-pack, with attention as before hinted to the temperature, is a valuable adjunct.

I daresay you have noticed after taking a bath that the feeling of thirst is sensibly reduced. This fact is suggestive (though I do not enlarge upon it) especially in cases of excessive thirst. Those who have been at sea, after shipwreck, and having no water—and, of course, knowing it would be dangerous to drink salt water, as that would only increase their thirst—have got relief by wetting their clothes with salt water. This, however, is only safe practice when they are able at the same time to maintain their temperature by food, etc.; otherwise the cold application and subsequent cooling by evaporation may hasten death by lessening their animal heat.

I have not been in the habit throughout this course

of saying anything about the indications of Divine wisdom or goodness in the structure of the body, simply because, in my judgment, that man studies physiology with very limited intelligence, who does not come to the same conclusion as that reached by the old Greek physician: "The human body is a hymn of praise to its Maker."

VI.

THE NERVOUS SYSTEM.

YOU are all familiar with the old story of the shield composed of two materials. The knights approached it from different directions; one of them saw a golden shield, and the other saw a silver shield. They disputed as to the structure of this piece of armour, and, as the story goes, they at length came to blows. We are told that they might have settled their dispute very readily, if each one had passed round to the point of view occupied by the other. It is sometimes said that disputes between philosophers and physiologists are of this kind. We look at the subject from two different stand-points, and if we changed our mode of examination we should be likely to arrive at an ultimate complete agreement. Nowadays, we are told something more. It is maintained that just as that shield had two sides, so has nervous matter, or, indeed, matter of any kind. It is asserted that nervous matter has two sides—an upper and an under, a mental side and a material side. We are told not only that matter has in itself the potency of

life, but the potency of *all* life, and that intelligence and will are as much properties of matter as growth and development.

In this lecture I have to speak of this wonderful substance in which these distinct qualities of matter are said to exist in this wondrous unity. And I venture to say, before proceeding further, that for my own part, I have never been able to discover the mental side of matter. I should not be at all shocked if it were proved to me that from brain or nerve, ideas, memory, emotion—all that we understand by intellectual life—may as really be developed as motion from muscle. I think I could maintain all that is vital in my relation to God and my fellow-men, in spite of that startling discovery. So that it is not because I feel that there is any irreconcilable antagonism between this form of materialism and the religion which I cultivate, that I am prepared to vindicate my doubt and disbelief. My rejection of this double-aspect theory of matter rests on very simple and intelligible grounds. Just as we found that we could not explain the action of living things, without predicating something more of them than was possessed by dead matter, and just as we were constrained to give the term "life," the only fitting word, to this something more; so I predicate "mind," when I witness actions performed that indicate purpose and will—of which purpose and will I am personally conscious as determining my own conduct.

Some years ago, a certain school of philosophy made the discovery that the attempt to find out the laws and operations of mind, by examining our own consciousness and by studying the records of the consciousness of others, was neither successful nor sufficient. They complained that it had not led to any definite results, and they maintained that it was only by a change of front, issuing in the confinement of our investigations to an exact examination of the physical structure of the organism that is concerned with the process of thinking, that we could expect to arrive at any result likely to prove satisfactory and complete. Well now, for several years the study of philosophy through physiology has been very widely pursued, but I am not aware that any very notable discoveries have been made up to the present date. I am not even aware that any very notable discoveries in connection with physiological facts have been made by our physiological philosophers. I am far from hinting that the philosopher ought not to know something about physiology, or that the physiologist might not with advantage learn something about psychology, or the science of mind. But I venture to say, that we have not had the boasted discoveries that were sure to be made produced up to the present hour. No doubt there have been certain investigations of very great interest; and I suppose there will be others of a similar kind in the future. But as to the action

of mind and the nature of mind, or, as they might prefer to phrase it, the thinking action of nervous matter and the nature of nerve-thought, our physiological students leave us as much in the dark as we were before they commenced their dissections. And indeed I cannot see how it could well be otherwise. We may examine the *instrument*, but that does not give us full-orbed knowledge relative to the operator and the operation. I think that any one who is acquainted with the movements of his own mind, and has considered them carefully, really possesses as much information in regard to these mysteries—memory, association of ideas, thought—as any one who has dissected and microscopically examined all the nervous tissues of the body.

In speaking to you of this nervous system, I may best begin by asking: What are the nerves? To this two answers may be given—one by the anatomist, examining simply their structure; and another by the chemist, examining the materials that compose them. We may dismiss the chemist's answer first. He will tell us that the nerves are composed of water, albumen, cerebral fat, osmazome, certain salts, and phosphorus. We do not get much relevant information from him. The anatomist will tell us that a nerve may be either a nerve centre or a nerve cord; that it may be a little body, or a mass of little bodies, occupying a certain definite position in the body; or it may be a thread

of communication connecting these little bodies, or larger bodies, with some other part. In other words, we have centres and conductors. Let us begin with the conductors. I dare say most of us are familiar with the general appearance of a large nerve, as it may be seen when exposed in the human body. It looks just like a white cord proceeding from one point to another. But let us not mistake this, as if it were one simple uncompounded line of communication between one part and another part. Any such nerve that we may separate, or take out and examine, is composed of an immense number of nerves, or of nerve fibres united together in one bundle. Probably many of you have seen a section of the Atlantic cable, or some other large medium arranged in a similar manner for the conveyance of electric discharges. In that section you noticed a large number of wires embedded in some material and enclosed in a protective covering. In like manner, in a so-called single nerve, such as the one we find in the fore-arm, we discover on closer examination a great many distinct fibres, corresponding to the wires of communication in the cable, which fibres are really separated one from another, while at the same time they are bound up in one common sheaf.

Let us separate one of these fibres, and examine it more minutely, by means of the microscope. We find it is composed of three parts. Let me use a com-

mon illustration to give you an idea of its structure. Take a candle and wrap round it one fold of stout paper. Lifting it thus enwrapped, you hold in your hand three distinct things,—the outer covering, the grease or wax, and the wick. So in the nerve we find that there are three parts—the outer protective sheath; an inner white substance; and an innermost rod of semi-fluid matter which is called the axis cylinder, or nerve proper. This white substance — called the white substance of Schwann — seems to act as an insulator, preventing the axis cylinder from misdirecting, or spending valuelessly, its energy. What I have called the nerve proper, the innermost substance, is used for the purposes of nervous communication, and corresponds in position to the wick of the candle. As I have said, this is not solid but gelatinous. When it is freshly taken from the body we find it in a semi-fluid condition.

It has been a question hotly and much debated: What is the process, the nature of the communication, that takes place along the cord? Indeed, physicists are not even agreed at this moment as to whether *electricity* is matter or force. Some hold it is material; others hold that it is simply a form of energy. You cannot therefore wonder that physiologists are not agreed as to the process or method whereby communications take place along the channel of nerve fibre. Descartes supposed that nerve-action was dependent on a nervous

fluid conveyed by this axis cylinder; that something, which he could only speak of as a fluid, travelled along its course. Hartley, later on, described nerve-communications as vibrations. Just as we can stretch a cord from one part of a room to another, and cause a vibration to travel from one end of the cord to the other, so he thought movements travelled along the line of the nerve. Galvani thought that nervous action was electrical. That theory, though plausible, has ceased to be popular with students of physiology. For it has been ascertained that, in various important respects, there is no agreement between this nerve-force—if you will allow me to use that expression—and the electric current. Nerve-force does not respond to the ordinary tests for electricity. We can break nervous communication by tying a ligature round the nerve, but we cannot so interrupt electrical communication along a wire. Besides, electricity travels at the rate of 462 *miles* in a second, and nerve-force travels at the comparatively slow rate of 240 *feet* in a second. There is a very great difference in these and other respects between the two forces. I do not contend that there is no analogy between them, and that for purposes of illustration we may not make use of many terms derived from the science of electricity to explain the nature of nervous action. But I may say that it is almost universally admitted now, that if nervous action has any *relation* whatever to electricity, nervous force

itself is not such electricity as we are familiar with outside the body.

Later still, we find some prominent physiologists speaking of the nervous current as due to polarity. A change in the arrangement of the molecules of the nerve, similar to that which takes place in the particles of a piece of soft iron when rendered magnetic by the galvanic current, is supposed to determine their activity. Allow me to give an approximate illustration. A number of balls are placed on the table before me. One of them stands a few inches from the others which are in successive contact. I push the detached ball against the line; the force travels along the balls until it comes to the last, which, standing free on one side at the other end, is sent off from the linked series to a distance measurable by the force applied at the other end. The arrangement of the balls is now altered. The one that was a few inches apart, is now touching the first in the series; and the one that stood last in contact with the others, is removed to a distance of a few inches. Another and closer illustration has been put in this form. Take the two letters D, O. We may have these letters arranged in a series after this fashion: O stands alone at the beginning; then DO, DO, DO, DO; while D, standing also alone, brings up the rear. Now we may change the arrangement: D standing alone at the beginning, followed by OD, OD, OD, OD; O now standing alone to close the series. So, if I apprehend

this theory of polarity, there is a re-arrangement of nerve-molecules during the passage of a nerve current [1] I do not think that helps us much in understanding the nature of the action. The truth is that we are really ignorant concerning the *nature* of nerve-action; we only know that there is such action, and that it travels in certain directions, according to certain observed laws.

Now I have spoken already of two kinds of nervous-tissue, cords and centres, conductors and—what shall we call them?—communicators. I do not know that that is a correct word to use, because we are not certain that these originate force. But for general purposes, and as an expression of a widely accepted theory, I may allowably use this term. There are many varieties of opinion held in regard to the nerve-centres. Some think that they are able to store up nervous force; some think that they are able to register impressions under certain conditions; some think that they generate the nervous force that is transmitted along the lines of communication.

A nerve-centre may be represented as a cell, thus ⊙. I suppose you are familiar, by this time, with the general appearance of a cell, as we represent it at least, diagramatically. We have here what may be called a nerve-cell. Then I may draw a line  to represent a

[1] For a full statement of this theory, see Todd and Bowmen's *Physiology*, vol. i. p. 230.

nerve-cord. Now, although these nerve-cells are of the same structure throughout the body, and the same may be said of the nerve-cords, they serve different purposes in different positions. For instance, from this nerve cell there may be another transmitted to a muscle at this end , causing the contraction of muscular fibres; just as I now issue an order to my fore-finger which causes it to raise itself aloft from the other fingers. That order has come from the nerve-centre, and has been transmitted to the muscles employed in making this change in the position of my finger. Then we may also have nerves connecting the centre with the skin . And although there may be no action *from* the centre to the skin (S), there may be action from the skin (S) *to* the centre. In the former case, we have action from the centre to the circumference; in this case, we have action from the circumference to the centre. In the one case, we have a nerve carrying an order out; in the other, we have a nerve carrying an impression in. Yet this nerve-centre that gives the order is the same in structure, it may happen the same identically, as the one that receives the impression; and the cord connecting both is precisely the same in structure, differing only in its distribution. In the one case, it goes to the muscle; in the other, it goes to certain little skin-organs that give us the sense of touch. The truth is, we cannot distinguish between nerves except by observation of

their position. We can find, by observing where they go and what they do, what the nature of their action may be, but nerve-cords or nerve-centres are identical in structure throughout the different parts of the body. The nerve that goes to the liver, giving the order to secrete bile, is the same in structure as those that go to the muscles, or those that come from the skin, or those that go to the stomach and give the order to the glands to secrete stomach juice. The nerves are the same in all their structural characteristics throughout the body, and the difference of action is simply determined by the difference of organ *to* which they go, or *from* which they come. Their relations determine their uses.

Taking the simplest form of what is called a nerve-arc, that is to say, a communication from the circumference to the centre, with a return communication from the centre to the circumference — a process round from the outside to the centre and back again to the outside—we find that many actions are performed automatically: that is, without apparent reference to any other part of the nervous system than the nerve-centre and cords concerned directly in the action. If we are on our guard against an illegitimate significance that may attach to the term "automatically," we may use it safely and it will prove convenient.

A fly lights on the back of my hand. It irritates the skin and my hand is drawn away. I am reading a

book, or engaged in conversation at the time, and I have no consciousness either of the irritation or of the removal; my attention has not been called to it. Yet the sensation has somehow or other reached a nerve-centre, and the order has been issued from that centre to remove this part of the skin from the influence causing it. Within the organism there are many acts of this kind continually taking place. There is one notable case that occurred in the practice of the well-known John Hunter. One of his patients was paralysed in the lower part of his body. By the severance of his spine he had no power of motion or sensation below the point of injury. But when his leg was pinched it was violently retracted or drawn away. John Hunter said: "Do you feel that?" The man naïvely answered, "No, sir, but my leg does." And he was as nearly right as could be under the circumstances. He had no consciousness of it, because it was not translated into consciousness. It was not sent up to the certain part of the nervous system where these things are referred to distinct action, and where sensations are recognised, so that he himself was not aware of this action upon his leg; but it was sent to *a* nerve-centre, and that nerve-centre immediately sent out the order to the muscles connected with the leg to remove the irritated part from the unwholesome action.

Nerves are associated both with motion and feeling. Does one and the same filament serve to move a

muscle and to excite sensibility? This question was first distinctly put to himself by Sir Charles Bell, and led him to make these inquiries and experiments which resulted in the remarkable discoveries that gave a new departure and value to nerve physiology. "Let us examine," he says, "in what direction the nervous influence which gives birth to motion must necessarily be transmitted through the entire length of a nerve so as to produce muscular contraction. Since will has its origin in the brain, and the force, whatever it may be, which acts upon the nerve must be diffused towards the muscles, it is evident that this force will proceed from within to without, or as a *centrifugal* force. But when a sensation takes place,—since the effect must be produced by the impression made on the extremity of the nerve expanded under the epidermis, and transmitted by the nerve itself to the sensorium,—it is also evident that this second force is a nervous current which proceeds from the circumference to the centre, or a *centripetal* force. In a word, the force which precedes muscular contraction runs along a nerve in one direction, and the force which causes sensation runs in another. Is it then logical to suppose that the two forces cross each other thus; that the same nerves, or the same portions of the nervous centres, exercise two functions at a time?"[1] The investigation of this sub-

[1] *Anatomy and Philosophy of Expression.* Appendix. 4th Edit. 1847. Quoted in Pichot's *Life and Labours of Sir Charles Bell*, p. 91.

ject issued in the establishment of a distinction between nerves of motion and nerves of feeling—the former being called *motor* nerves, and the latter *sensory* nerves.

At this stage I may indicate that we have two groups of nerves in the human body. One group—comprising the brain, the spinal cord, and the nerves proceeding from them—is commonly spoken of as the *cerebro-spinal axis ;* the other group, formed by a series of ganglia (knot-like masses) intercommunicating by threads on each side of the vertebral column, is called the *sympathetic system* of nerves. This latter system, the sympathetic, is mainly occupied in conducting the processes of organic life. It sends branches to the large organs in the chest and in the abdomen, and also to the blood-vessels. I must add, however, that nervous influence is supplied from the *medulla oblongata* (oblong marrow), at the base of the brain, to maintain the vital process of respiration and to assist in directing other organic functions. In the medulla there is a part called the respiratory track, from which one large nerve (the pneumogastric) takes its rise, the fibres of which can be traced to the lungs, heart, liver, and stomach.

A great many of these actions that are called organic take place apart from any cognisance that we may choose to take of them, and to a large extent apart even from consciousness. I have some power over

my breathing. I can restrain, lessen, or quicken it by an effort of will; but I have no power, or very little, over the action of the heart. Emotion acts on the heart, but will or purpose does not seem to affect it much. And we have no appreciable power over such internal organs as the stomach or liver, although, in these cases also, emotions or anxious thoughts have some power, as all those who have been troubled, either by abnormal action of the liver or stomach, have learned by sad experience.

I am concerned for the present mainly with that system of which the brain and spinal cord form the leading features. We are not to suppose, however, that the other nerves in the body that I have spoken of under the name of the sympathetic system are altogether independent and separate. There are communications between the fibres of these nerves and the fibres that come from the cerebro-spinal system, and there is a unity given to the whole body in consequence. But it would appear that there are a great many nerve-centres that act readily and constantly without any need of communicating their action to what we may call the influential or the higher part of the nervous system. Permit me to remind you that we have already learned that there are nerve-centres and nerve-cords. We have now to recognise the fact that there are higher centres to which these lower centres may report, and a highest centre—the brain—

which to some extent takes cognisance of and exercises control over all. Dr. Draper, in his treatise on Physiology,[1] suggests that these higher centres may be registering centres, and that the highest of all (the brain) constitutes what may be termed the influential arc. By this arrangement excitement of a nerve filament carried only to its own centre may simply give rise to a reflex motion; or carried higher, it may give rise to other associated motions; or carried finally to the brain may give rise to consciousness, and to such results as may follow therefrom. It is supposed that the cerebral hemispheres have something to do with this translation of nerve-action into consciousness. At the same time, I am anxious to guard you against supposing that we are able to account for or explain this translation. We cannot follow nerve-action into consciousness. Consciousness is a novel fact; and it cannot be fairly spoken of as a product. Bile is a *product* of the liver, gastric juice is a *product* of the stomach—and we can trace the changes through which these products are reached; but we cannot connect thought or consciousness with any action of nerve-fibre or nerve-cell. I must ask you distinctly to apprehend this truth, that changes in nerve-matter and emergence of thought belong to two distinct spheres—they may be in the closest possible association, but they are not commensurate; we cannot possibly con-

[1] Draper's *Human Physiology*, p. 280. 2nd Edit.

ceive or speak of them in the same terms. There is a chasm between them over which it is impossible for us to pass.

It may be said, fairly enough, You have material forms—nerve-centres and nerve-cords—and you admit that motion may be transmitted from the one to the other; is it not possible to enlarge your conception and to suppose that in some way ideas and emotions of different kinds may be evolved from the same materials? My objection to framing any such supposition is at least an intelligible one. We are able to trace the transference of motion from one body to another; but when we are asked to translate motion into thought we are non-plussed. Motion can be translated into heat; it can be translated into electricity; it can be translated into other physical forces of the same class as itself: but we have no experience that will enable us, for a single instant, to grasp the conception that it can be translated into thought. And I venture to say, that it is for those who maintain that this is possible to furnish us with the reasons and to formulate the method. I have read with some care many of the arguments adduced in this direction without being in the slightest degree convinced by them. Not that I am unwilling to be convinced. I would not feel that there was anything lost—I might even recognise something gained—if it were possible to translate motion into thought. But my mind, con-

stituted as it is, cannot grasp or understand the possibility of this translation of physical movement into thought or emotion.

Let me now recall your attention to those movements that are called reflex. Sir Charles Bell, examining the two roots from which the nerve—or rather the many nerves inclosed in one sheaf—spring from the central cord in the vertebral column, and are distributed to the muscles and the skin, etc., pointed out that these two roots have different functions. They have also different places of origin—one rising from the anterior or front portion of the spinal cord, the other from the posterior. By cutting across the one in front and the one behind in succession, he proved that the one was concerned with sensation, and the other with motion. By dividing the anterior or front root, he found that on stimulating the cut end *next to the vertebral column*, there was no feeling and no result; but that on stimulating the cut end which was still in communication with the fibres *leading to the muscle*, the muscle contracted. On dividing the other root—the posterior root—he found that when he excited the cut end next the spine there was pain felt; but when he excited the other cut end that was in communication with the fibres going to the surface, no feeling or action followed. He thus demonstrated a distinction which has been accepted ever since between the two kinds of nerves. The nerves of *anterior*

origin are lines of conveyance *from* the spinal cord; they are *motor* nerves, or, more correctly, *efferent* nerves—nerves carrying out something to the circumference. The nerves of *posterior* origin are *sensor* nerves, or, more correctly, *afferent* nerves—nerves whereby impressions are conveyed *to* the nervous centre.

As I have said, we may have direct transmission of a message from the outside to the inside, and a response sent almost immediately from the inside to the outside; in other words, the motion of the nerve may seem to be reflected or sent back again along the course of the other nerve. It is more correct to say that when the intelligence reaches the nerve-centre, immediately there is a command, or stimulus, conveyed along the line of the other nerve determining a certain result in the part to which it is distributed.

When we examine the distribution of these nerves we are unable to say precisely how they end. It is disputed whether they end free or in knots, or whether they are continuous with the structures into which they pass.

I do not know that any theory would be universally accepted in regard to nerve-action. Probably the following explanation, which you will find frequently given, is as helpful and as exact as the present state of our knowledge admits.

Let me first say, however, that a large amount of

nervous energy or action is not equivalent to a large amount of strength. There is no necessary connection between these two things. We get the force we use, as we shall have occasion to note later on, from the food we take into our bodies, conditioned by the state of the body into which it is conveyed. Any force that we may have in the nerve-current has been gained after the same fashion as the other forces that are used for other purposes. So that a man possessed of a large amount of nervous energy may not necessarily be a man of very great strength. A man might have a very active nervous system while possessing a very limited store of energy available for work. And it is easy to form the reverse conception of a large amount of work-force without proper appliances for its direction and use. We know that, if we have gunpowder properly placed in the barrel of a gun, a single spark will cause it to explode, and the liberation of the gases contained in the gunpowder by this explosion will send swiftly a solid ball of lead a considerable distance. We have these gases in the gunpowder; you may say we have got the latent energy stored up in it, but how is it to be set free and made available for action? It can be set free by fire. I take the percussion cap containing the fulminating powder and put it on the nipple of the gun, and by bringing down the hammer I at once produce the needful spark which, reaching the gunpowder, liberates the

gases, and the missile is sent in the direction desired. Now it has been suggested that the nerves do for the muscles and the secreting glands very much what the detonating cap does for the gunpowder. The liver does not act until it is stimulated; the muscles do not act until they are stimulated. They have in themselves the power of contraction or secretion, but they require this stimulus to bring these powers into play. And it is suggested that it is by means of the nervous force or current that we are able to set free these forces either in the muscles or glands.

We can thus acknowledge the importance of the nervous system, while at the same time we do not overestimate its value.

There are many experiments on record, proving amply enough that electrical irritation produces action along the nerve-cords. Very interesting experiments in this direction have also recently been made by Professor Ferrier in this country and Hitzig in Germany, specially locating the centres of certain actions in distinct parts of the brain. It must not, however, be concluded that these experiments give us a sufficient explanation of nervous action. I am not now questioning the absolute value of the information which may be thus gained. It is not denied that motion may be communicated to a nerve-cord by electricity or by irritation; which motion, conducted by the fibres, produces a definite result where these fibres terminate.

But what I ask is this: How is it that the same motion originates *without* electricity, in the individual, independent organism? By exciting electrically the end of a nerve I produce the contraction of a muscle, but I can produce the same contraction without any such irritation. I can produce it by an act of will. I wish to raise my hand, and it is done almost as soon as I wish it. I can act directly upon these nerve-centres, in a way that is not explained by these electrical excitants or other irritants that are applied to the nerve-cord. Do not let us run away with the idea that, when we find in this way that motion can be communicated by other agents to the nerve-cord, we have solved the problem of the action of nerve-centres or cords within the human body. That problem remains as insoluble, or at least as unsolved, after you have made these discoveries as before you began your inquiries.

And I venture to say, that what is true in regard to motion is more abundantly true in regard to sensation and consciousness. It is generally stated in books that the cerebral mass is the organ of mind. I am not prepared to contend that this has been thoroughly and completely demonstrated; but I may fairly enough assume it as a generally-accepted belief. Admitting that brain is somehow associated with thinking, whence comes the power that calls it into activity? You tell me that brain is the organ of mind. But then, what

plays on the organ? What uses it? Nerve-matter can be excited by electricity or irritation, but what acts on it in the absence of electricity or irritation? How is it that this organ within itself (*ex proprio motu*) has the capacity of originating and expressing and recording ideas of various kinds? and how does it independently and originally excite to action? I do not think that we have got one whit nearer to any satisfactory answer to these questions after all our microscopical, anatomical, and chemical investigations. The problems remain still problematical. I am not saying that I can prove that there is a thing called mind, visible or invisible, spiritual or non-spiritual; but I am saying, that we have come to an end of our intelligence of the matter when we reach the fact that it is through the direction and use of this cerebral mass—by the *mediation of the brain* if you will—that these different results follow. The *user* and *director* we are not able to see or to describe; and yet that there is such a user or director is our earliest recognised intuition, the most ineradicable conviction we possess.

There are a great many questions suggested by the structure, arrangement, and relations of nerve-tissue that have not hitherto received full attention. What is the meaning of the marked difference in structure between the brain and the spinal cord? If you examine the structure of the spinal column you find that it is composed of two kinds of nervous matter—a

white, and a reddish-grey or ashen-coloured layer. These occupy distinct positions. The reddish-grey is inside, and the white outside. The white is fibrous, and of the same structure as the nerve-cords. The reddish-grey or ashen-coloured is supposed to be nerve-centre material, and it is in this that nerve-action is supposed to be originated or stored. When we examine the brain we find that these two kinds of nerve-tissue are placed in reverse order—the reddish grey is on the outside or surface, and provision is made for a very large amount of it in some cases, by a series of surface-foldings or convolutions; while the white tissue is inside. I am not sure that we have reached any definite knowledge in regard to the distinct uses and relations of these two parts of the two great nerve-centres—the brain and the spinal cord.

It is generally admitted that we recognise differences between animals corresponding mainly to the difference in size of brain and to the difference in form and quality of brain. I note that statement as to form and quality because some brains, for instance, may have a much larger amount of this surface brain-tissue (the ashen-grey nerve-tissue), because they are marked deeply by a larger number of these *in-foldings* or convolutions.

I do not enter into details connected with the structure of the brain. They are of no importance for our present purpose, and at present our know-

ledge of their significance is very limited. I may say here, however, that it is a favourite idea with some physiologists that mental vigour is greatly conditioned by the number and depth of the brain-convolutions. These, as we have noticed, determine the amount of surface brain-substance — the reddish-grey or ashen-coloured nerve-tissue. This surface-tissue is supposed by some to have a more immediate connection with thought and mental power; so that it has become a very widely-accepted opinion that "intellectual eminence is associated with the number and extent of the convolutions of the brain."

While it is true that animals have their position in the scale of intelligence determined to some extent by the size of their brains, yet that is by no means to be accepted as a rigid standard. Primarily, of course, we have to take into account, not merely the size of the brain, but also the size of the brain relatively to the body. An average male human brain is about 49½ ounces in weight. The brain of the female is 44 or 44½ ounces. Some may be inclined hastily to conclude that woman is therefore an inferior creature, but you must remember that a woman's body is proportionately less. We find that in man the weight of the brain corresponds to the weight of the body in the proportion of 1 to 40.[1] In the marmozet we find that the brain corresponds to the body in the proportion of

[1] That is, the weight of the body is forty times that of the brain.

1 to 20. In the case of a child we find that the brain is very much larger in proportion to its body (at birth 1 to 10) than is the adult brain. It must be said, that in the case of the marmozet the convolutions are almost entirely absent, and that fact may make a difference in regard to force. But we have other cases in which there are convolutions, and in which there are nevertheless startling peculiarities for which we cannot account. The elephant carries an immense mass of matter—somewhere about three tons; but its brain is not more than three times the weight of the human brain.[1] Yet the elephant, with a brain only three times larger than ours, and with such an immense amount of bulk beyond ours, ranks very high in intelligence.[2] So that we are not to assume that size of brain, or quality, or number of convolutions, settles the whole question in regard to the scale of intelligence or mental power. The truth is, when we come to examine this subject in detail, we find so many abnormal facts which we are unable to classify, that we are left in very grave doubt at the end. It has been suggested, and the suggestion has some force, that the "elaboration of brain is connected with de-

[1] The brain of the whale is not more than twice the weight of the human brain, though the weight of the whale is sometimes sixty tons! The convolutions of the whale's brain are, however, very intricate.

[2] The brain of the elephant is, however, the largest animal brain known.

velopment of the muscular system."[1] There are many reasons that could be produced in support of that suggestion. The truth is, we are not yet furnished with definite data on which to base arguments whereby we may reach satisfactory conclusions. Even if we take for granted that the brain is the organ of mind, or, if you choose, that brain is mind, that hypothesis, if honestly applied, will be found to raise quite as many difficulties as it may seem to remove.

Then, besides, while admitting that the brain, or the nervous system generally, has a definite relation to mind and to mental action of different kinds, yet there are still some anomalous facts to be explained. If we take away the brain proper from a pigeon, we find that certain faculties remain; but the bird is unable or unwilling to originate action. It can see, and if you throw it into the air it will fly, but if it is not raised again after it reaches the ground it will make no motion; it will remain inactive and apparently stupid until it dies of starvation. If you press food into its mouth it will swallow it, but it will not collect food itself, though a plentiful supply of food be near. It will not originate action, but will direct motions given to it, to some extent. I do not suppose this experiment has ever been made on a human being, but there have been cases in which children have been born without this brain-mass, and have lived for some

[1] Calderwood's *Relations of Mind and Brain*, p. 206.

time. This cerebrum—according to our information gained from these experiments, or this pathological condition—is concerned in the *origination* of certain actions; but even such actions may be originated by impressions made from without, and various processes that ordinarily are largely under the control of the brain may be carried on in its absence.

While we speak correctly enough of the brain as intimately associated with sensation and intelligence, and while it is generally believed that the cortical[1] or outer substance has the closest relations with feeling and thinking; yet this brain substance may be removed in slices without pain, and even a large portion of one side or hemisphere of the brain may be injured or destroyed without any apparent loss of *mental* power.

The brain is a double organ, consisting of two hemispheres, united at the base by bands called commissures. Recently it has been argued by some that we have two brains; and it has been further maintained that from want of early training and development nearly one half of our brain power is unused. There are many curious and interesting questions raised by this hypothesis, on which my limits do not allow me to enter.

This, however, is certain, that the *mind relations* of

[1] The surface matter is called *cortical* because it resembles in position the *cortex* or bark of trees.

the brain are not the same as its *physical relations.* Dr. Ferrier calls attention to this in the following suggestive statement. "The physiological activity of the brain is not, however, altogether co-extensive with its psychological functions. The brain, as an organ of motion, sensation, or presentative consciousness, is a single organ composed of two halves; the brain, as an organ of ideation or re-presentative consciousness, is a dual organ, each hemisphere complete in itself. When one hemisphere is removed or destroyed by disease, motion and sensation are abolished unilaterally, but mental operations are still capable of being carried on in their completeness through the agency of the one hemisphere. The individual who is paralysed as to sensation and emotion by disease of the opposite[1] side of the brain (say the right) is not paralysed mentally, for he can still feel and will and think, and intelligently comprehend with the one hemisphere. If these functions are not carried on with the same vigour as before; they at least do not appear to suffer in respect of completeness."[2]

The truth is, the correlations of mind and brain are as yet untraceable. That there are decided and intimate relations between thought and nervous matter does not seem to be questionable. It

[1] The opposite side of the body is affected because the nerve fibres from each hemisphere *cross over* to the opposite side.

[2] *The Functions of the Brain*, p. 257. By David Ferrier, M.D. F.R.S.

can hardly be disputed that here we have reached a region where mind affects matter and where matter affects mind. Beyond this, however, we have not yet advanced. We are not able to group together any corresponding facts. In cases of mental unsoundness there are no invariable lesions of the nervous system to which we could refer errors in thought or feeling; and even if there were, it might be difficult to say whether they ought to be classed as causes or consequences. And, on the other hand, genius, or outstanding intellectual superiority, cannot be demonstrated by the scalpel or the microscope.

We may admit freely enough that the nervous system is the medium of communication between intelligence and matter. And this admission, I think, may fairly cover a large number of cases in which strange mental vagaries and freaks result from the condition and circumstances of the physical organism. As an illustration, and also because it is of practical significance and value, I may refer here to the action of alcohol on the brain.

When this poison finds its way into the blood it acts in a very decided and injurious manner upon nerve-tissues. It lessons their sensitiveness and dulls their action. The individual thus intoxicated or poisoned is less capable of directing his actions and doing what he ought to do, or even what he wishes to do. If the quantity taken be small, there may be only a blunting

of the fine edge of consciousness and right feeling. Of course, the effect produced is proportioned to the amount taken.

But when larger quantities are taken, there follows a very marked decrease of physical sensibility, accompanied with mental stupidity and decided loss of the power of moral self-government. Omitting further reference to its action on intelligence and conscience, let me speak only of its effect on sensibility. You remember that I formerly maintained that alcohol instead of increasing animal temperature actually lowered it, when taken in large doses. Yet any one might fairly have answered me then: "It may be true that the temperature of the body is lowered, judging by the thermometer; but I know that if I take a sufficient quantity, although I have been shivering from the effects of external cold previously, I begin to feel quite comfortable, and this relief from the painful sensation of cold continues for two or three hours. How do you explain that?" Simply in this way. We have lowered our sensibility throughout. We have made ourselves to some extent incapable of appreciating the depressing action of the external atmosphere on our system. We have silenced the warning sentinels by sending them to sleep. Allow me to use a simple illustration. An old lady wishes to cross the street from the Bank of England to the Mansion House. She does not like the sights or sounds; the driving to and fro of so many vehicles, the noise of

the horses, and the shouting of the drivers make her timid and nervous. How can she get rid of these causes of alarm? She puts one finger into each ear and shuts both her eyes tightly, and commences to walk across! That may make the transit comfortable; but does it make it safe? That is precisely what we do when we take alcohol. We dull our senses, and so remove the discomfort; but we certainly do not raise the temperature of the atmosphere that surrounds us, nor do we increase our animal heat, we only lessen our appreciation of danger, and thus facilitate and increase our exposure to injury!

VII.

SPECIAL SENSES.

JOHN BUNYAN, in his story of the capture and recapture of the noble town of Mansoul, tells us that it had five gates: Ear-gate, Eye-gate, Nose-gate, Mouth-gate, and Feel-gate. And the late Dr. George Wilson, in a very noteworthy little book on the senses, makes use of the happy expression, "The five gateways of knowledge." It is by means of these inlets that we become familiar with the facts of the outer world. There are questions of a very interesting kind raised concerning the origin and nature of our knowledge. Some of you may be aware that for a long time it was held that all our knowledge was supplied by the senses. John Locke maintained that we gain knowledge by sensation and reflection. Liebnitz afterwards argued that there was nothing in the intellect but what was first in the senses, *except intellect itself.* And although it has been urged that this is a distinction without a difference, I am inclined to think that there is more in it than at first meets our sight. There is at all events a power to interpret and a power

to apply the information that we gain from without, that qualifies and conditions, to a very remarkable extent, the information itself. So far as our knowledge is concerned, it is quite evident that we are dependent on our senses to a very large extent, both for the nature and amount of that knowledge. Those who have been deprived of one or more of their senses have, in consequence, been shut out from a large mass of information with which we who are in possession of all our senses are familiar.

There is a very interesting account on record of Laura Bridgeman, who was thus afflicted, and of the means used for making her acquainted with the different facts and truths which she was unable to gain directly for herself.

We have noticed also that in cases where one or other of the senses has been lost, or is wanting, there is a special increase of power attainable by the other senses, so that the lacking information may be in some measure supplied. We are familiar with the fact that blind people, by means of their sense of touch, whereby they are even sensitive to slight movements of the air, can make themselves acquainted with a great many facts that we only recognise by means of vision.

Speaking generally, it may be asserted that our information of all things that happen without us is conveyed to us by means of these five senses. I am

not forgetful of the fact that we are not limited to them for our knowledge of sensations, or for our feelings. There are other sensations such as may arise, for instance, from pressure on the brain, or which may be caused by inflamed vessels of some of the deep parts of the body, or such general feelings of uneasiness as may result from fatigue after long-continued exertion. These are evidently internal sensations, and they are not conveyed to us through the channels of what we commonly call the five senses. But for our relation to the world without, and for our acquaintance with the facts it presents, we are dependent on the modes of access styled by John Bunyan, Eye-gate, Ear-gate, Mouth-gate, Nose-gate, and Feel-gate. It is of these five senses that I purpose speaking in this lecture.

For convenience of treatment and apprehension, we may begin with the simplest and ascend to the more complex. First, then, let me speak of TOUCH. This, unlike the other four, is not located in the head or face. We find that it is diffused, to a greater or less extent, over all parts of the body. A very interesting experiment has been devised for testing the amount of feeling in different parts of the body. A pair of compasses are taken with the ends somewhat blunted. The two points are applied to the skin in different regions. It is found that on the tongue we can distinguish the two points when they are very

close together; on the fingers we can only distinguish the two points when they are a little more widely separated, and on the back we cannot distinguish the two points until they are separated to some distance from each other. The amount of sensibility in different parts of the body can be determined with considerable accuracy by this experiment.

We know that generally the faculty of touch is exercised by means of the hand, and, more minutely, by means of the fingers of the hand. We can educate the fingers to a very large extent indeed, and can gain a vast amount of knowledge by their delicate discrimination.

Have you ever seen a sermon preached to people that were deaf? I ask, have you *seen* the sermon preached? because, although sermons are ordinarily heard and not seen, in this case the sermon must be directed to the eyes and not to the ears. The preacher must use his fingers instead of his tongue, and by means of these he must express all the ideas that are present to his own mind. I recollect seeing in an assembly of this kind—I cannot say audience—one woman who was blind as well as deaf. Now the question is: How could these words thus set forth on the fingers reach her mind, seeing that she had no eyes to see and no ears to hear? It was done very simply. Another of these deaf ones beside her took

one of her hands in her own, held it up, and made signs with her fingers on different parts of her hand, mainly on the fingers, corresponding to the signs made by the speaker (if I may call him a speaker), so that to this blind and deaf woman were conveyed, by means of touch, all the signs that were shown to the eyes of those deaf women who could see.

We can, in various ways, educate this sense of touch, and make it much more thorough and available for useful purposes. We find that those who are obliged to depend largely upon the exercise either of the eye or the ear, or it may be the tongue or nose, are able to train these organs to a much more acute sensitiveness than is attainable under ordinary circumstances. Of course that has its limits. We may so overwork or fatigue such an organ as the eye, as ultimately to render it unfit even for ordinary purposes. But under certain conditions of careful continuous exercise these sense-organs may become stronger and more skilful. An Esquimaux can detect a white fox in a snow-field; and a sailor can descry a sail on the horizon where the landsman sees nothing.

In touching, we bring any part of the fingers—say the point of the middle finger—into contact with the substance that we wish to examine, and we can than speak of its hardness or softness, its roughness or smoothness, or possibly its coldness or its warmth. We find that a very considerable amount of infor-

mation concerning the qualities of the bodies that we touch enters by Feel-gate. We find it literally at our finger ends. Indeed, a very large amount of our knowledge in regard to the distance of bodies and in regard to the shape of bodies reaches us through the sense of touch rather than through the sense of sight. People who have been blind and who have subsequently gained the power of seeing have not been able in the first instance to determine the distance of objects; all things seem equally near, and there is no perspective; and there is reason to think that children, when they begin to use their eyes, have no ability to determine distances. Only when we bring in this faculty of touch to supplement the faculty of vision are we able to settle the relations and places that bodies occupy.

When we examine the skin we find a very peculiar arrangement on which this tactile sense depends. The nerves are distributed on the surface of the true skin, and are covered by the epidermis, or scarf-skin, which thus serves as a protection to the sensitive parts beneath. These nerves have, in certain parts, a peculiar arrangement called touch-bodies, in which we find a coil of nerve-fibre, and Paccinian bodies, which are like small seeds embedding the termination of the nerve in a soft substance.

There are in all these cases—and it is well to state it here and now—the terminal arrangement of the

nerve-fibre, where it makes acquaintance, so to speak, with the outer world; the nerve-cord, or conductor, along which the impression travels; and the nerve-centre, to which the impression being carried there results, somehow or other, a feeling or sensation. And do not let us forget this, that really lies at the basis of our study of all sensation; that we cannot pass by any effort of thought from matter as matter to sensation as sensation. The two things are distinct. We may, to a very large extent, make artificial imitations of different organs that we find in the body—say, for instance, imitations of the eye or ear. We can produce mechanisms adapted to receive light or sound; that is, to receive those vibrations of the atmosphere on which sight and hearing depend. I need not tell you, however, that these mechanisms are insensible. Except in the living body we have no sensation. Sensibility is peculiar to living organised bodies, and any descriptions of sight and hearing that leave this out of account, and are narrowed to the details of molecular or mechanical action, are deceptive and misleading. To such descriptions you must add the existence of a special faculty which is competent to translate in a fashion unknown to us, these vibrations of light or of sound into hearing and vision respectively.

In the simplest of all the senses, the sense of touch, we have ideas originated in consciousness somehow, by means of the contact between the exter-

nal organ of sense and the object that we are examining. The impression is propagated along the nerve-cord, and is translated somehow into sensation or feeling within our body, and, it may be, into an idea or recollection in our mind.

Let us next examine Mouth-gate. Here we find the tongue, which is commonly spoken of as the organ of taste. We are not to suppose, however, either that the tongue is confined to the task of tasting, or that this function is limited to the tongue. The human tongue may serve the highest ends in aiding to utter language the most ennobling; or it may give currency to words the most vile and degrading. If we examine the lower animals, we find that the tongue is, in many cases, the organ used for laying hold of external substances, and in some cases—in fishes, for instance—we find it has rows of teeth placed upon its surface, and it is intended, to a large extent, to operate in the work of primary digestion within the mouth. We find also that some animals use the tongue as an instrument for getting or grasping food. The ant-eater catches its prey by its tongue. We have the tongue used for a great many such purposes in other animals, indicating that it is not designed only and altogether as the organ of taste.

In man we find also that it assists in the process of mastication, rolling the food round and round in the mouth, bringing it into contact with the saliva, and

extricating any particles that may have got fixed among the teeth. Still it has a distinct use, along with other parts of the cavity of the mouth, such as the soft palate and upper part of the throat, in giving us what we call the sensation of taste. We find, just as in the skin, so in the tongue, there are *papillæ*—little elevations containing nerves that have this peculiar faculty of appreciating what we may term the sapidity, or tastefulness, of bodies.

We cannot taste any substance unless it is in a state of solution. I do not mean to say that all the substances we take into our mouth must be dissolved in liquid externally before we can appreciate their flavour. But they must be melted or dissolved within the mouth before they come into contact with these papillæ if we are to gain the sensation of taste. This does not, however, hold true with respect to gases. For instance, carbonic acid gas ordinarily gives no taste in the mouth. But if the tongue be dry, if the moisture be removed by any cause, and a stream of carbonic acid gas then plays upon the tongue, we find that we are now able to appreciate a distinct character or taste in the gas. But in dealing with substances generally, such as we use for food, their solution in the mouth, or before they are introduced into the mouth, is necessary, that we may be able to appreciate their taste. And I believe the tongue is placed in this position that we may form a fairly accurate idea

of the things that are good and the things that are bad before we allow them to pass further in. We have this organ to determine, to some extent at least, the fitness of the various substances we would introduce before permitting them to pass the barrier. Things that are unpleasant are generally to be rejected. I am afraid to speak very broadly or absolutely on this point, because I have a rational dread of my friends the physicians. They tell us that in some circumstances things that are very nauseous and disagreeable ought to be introduced into the stomach. But if you will allow me to talk of normal states and conditions of health, I think I may say that, under no limitation that I am acquainted with, the tongue determines with considerable accuracy, by its pleasure and satisfaction, those things that ought to be allowed to pass onward, and that its displeasure and dissatisfaction determine that those things which are disagreeable, just to the extent of their disagreeableness, are likely to prove injurious if they are allowed to go any further. We have naturally, a tendency to eject anything that is of this disagreeable character. It would be well—still speaking of ordinary cases, and not trenching on the province of our good friends the physicians—if we allowed that natural tendency fair and full play.

Right above Mouth-gate, we find Nose-gate, and as its position indicates it is directly associated with

tasting. Indeed, there are a great many things that we taste partly by means of these nerves in the tongue and mouth, and partly by means of the nerves of smelling in the nostrils. There are a great many things the savour of which we would not detect if we closed our nose tightly while holding them in the mouth. It is a very common practice when anything very disagreeable is being forced on children, to take hold of their little noses firmly, and to press the substance into their mouths, holding their heads well back, that it may find its way into their throat. The nose is placed right over the mouth that it may exercise a due amount of watchful care in this position. It is intended to be a sentinel like the tongue, and substances that have a disagreeable odour are to be shunned no less than substances that have a disagreeable taste. The nose is placed there for use, even though it may also be ornamental, and it is neither wise nor safe to neglect the intimations that it gives. Of course we may debase the sense of smell, just as we may debase the sense of taste, so that its likings become the reverse of right and natural. Many practices that are unnatural, and in the first instance abhorent, may become habitual and pleasant. Some people acquire a taste for bitters; and others gratify their nostrils by huge pinches *of snuff*.[1] We may learn in various

[1] A good story is told of a Highlander, who offered his snuff-box to a gentleman who had a rather large proboscis, and who was in-

ways to like a great many things that are injurious, and even greatly to prefer them to things that are wholesome. But in the normal condition, if anything that is about to be introduced into the mouth has a disagreeable odour, we are disposed to accept the warning, and to reject the malodorous substance. There is special provision made in the construction of the nostrils for the appreciation of smells. Fortunately the nose is a very prominent feature in the face, and although we cannot take off the outer covering, yet a few words of description may convey a fair idea of its inner structure. We find it is divided into two cavities by a *septum*, or division, which is partly cartilaginous and partly bony; and each of these cavities is divided by a scroll-like bone[1] into three chambers lying one above the other. In the two uppermost the sense of smell resides; the lowermost being adapted, as we have formerly noted, for respiration. These bones are covered with mucus tissue, in which the filaments of the olfactory nerve are distributed.

The cavities of the nose serve also to give *timbre*, or resonance, to the voice, and when they are stuffed, as in catarrh, the voice becomes peculiarly flat and disagreeable. By this sense we are also warned when

haling the balmy air of the Trosachs with widely-dilated nostrils. When the offer was rejected, somewhat disdainfully, with the explanation "I never take snuff," he turned away with the exclamation, "Mon, its a peety, for ye have *fine accommodation*."

[1] These bones are called the *turbinated bones*.

certain noxious gases are present in the atmosphere. The nerves of smell within the nostrils are branches of what is called the olfactory, and some twenty or more of these branches come down through a bony plate in the upper part or roof of the nose, which plate, on account of the numerous little openings through which these threads pass, is called the *cribriform*,[1] or sieve-like plate of the ethnoid bone. By this sense we detect and discriminate odours. These odours seem to be given off in a gaseous form; but it is puzzling to learn that one grain of musk can charge the atmosphere of a room for years without any appreciable loss of weight. When we desire to gain information in regard to the odour of bodies, we perform a process familiarly known as sniffing. We pull up the air into the nostrils several times, and there in the chambers of smell it is subjected to a close and keen examination.

The three senses of which I have now spoken are very much alike, and in some respects we may consider them modifications of the first sense—the sense of touch.

When we proceed to examine Ear-gate, we find that it has a very different construction. The simplest form of an ear, perhaps, is that which we find in the lobster. It has on one of its feelers a little bag of fluid, on the inner surface of which there is a nerve spread out which transmits impressions to a centre.

[1] Cribriform, from *cribrum*, a sieve.

We find, as we ascend the scale of animal life, little hard, stony substances enclosed in this fluid-containing bag. The motions of these stones within the bag give more expressiveness and definiteness to the sounds by increasing the force of the vibrations. When we come, however, to man we find that the organ is much more complex. I need scarcely tell you in regard to the senses generally that we find other animals having much more acuteness in several of them than we possess. Not to speak of touch or taste—although I believe there are special differences in these also—we notice in the dog, for example, much more keenness of scent than we have ourselves. And in many of the uncultivated races who depend more upon their senses, than we do who cultivate our intellects, perhaps to the neglect of the senses, we find appreciation of differences that are to us indistinguishable. Humboldt tells us that the Peruvian Indians can distinguish the different races from each other in a dark room; they can tell the different nationalities by the smell alone. We are told of one boy who was, if I remember rightly, both blind and deaf, who could tell his friends by their smell.[1] We know that the dog can do this; it can trace its master even through a crowded street. We know that the bloodhound, particularly, can follow the scent of his prey for great distances. He does that by putting his

[1] McKendrick's *Outlines of Physiology*, p. 552.

nose down to the ground; because animal effluvia of different kinds do not seem to be so diffusible in air as others; they lie commonly near the surface.

So in regard to hearing, of which I am now speaking. There are great differences, even among men, as to acuteness of hearing. Some animals seem to have a wonderful power to appreciate and distinguish sounds at great distances. We ourselves know that when this faculty is cultivated—as it may be in certain directions—there is a large amount of interest and pleasure that may be gained. I am speaking now more particularly of our cultivation of this faculty in the appreciation and enjoyment of musical sounds.

When we investigate the structure of the human ear, we find it divisible into three parts—the external, the middle, and the internal. The external, which we can readily enough examine, seems to be adapted simply for the collection of sound, and is not so perfect in man as it is in many animals. They have external organs of hearing that are under the control of the will. They can bring these large lobes that we see lying on the side of their heads into different positions, best fitted for receiving such sounds as they wish to distinguish. We sometimes put our hand behind our ear in order to catch sound more accurately for discrimination, but in animals there is this special arrangement for the collection of air-vibrations.

A fair argument in favour of a backward evolution

has been raised in this connection. It is asserted that we have lost the power of moving the external ear through disuse.

If we follow the channel of the outer ear a little way in, we come to a membrane stretched across and closing the inlet, commonly called the drum of the ear—the *tympanum.* This membrane is very delicate, no thicker than gold-beater's skin, and therefore demands cautious treatment. It is very strong in proportion to its thickness, but it is quite possible to rupture it. People sometimes do so by introducing sharp-pointed instruments into the ear to remove the wax. A blow on the ear should never be given to a child, because this delicate membrane may be ruptured by the sudden compression of the air in front of it. Between this membrane and the inner part of the ear we have a space in which we find air, and at the other end of it another membrane, closing it in, and thus forming the true drum of the ear. We have the two membranes, the outer called the tympanum, and this inner membrane, with the air between. We find also that there is a canal from the mouth to this middle cavity, called in books the eustachian tube or canal, and by this communication the enclosed chamber has an occasional communication with the outer air. You know that in drums, in order to get sound from them, we must not only have parchment on both ends, but we must have a hole somewhere to

allow transit of air. You cannot get the volume of sound without this provision. If I strike a tumbler so (standing in its natural position), I get sounds distinctly enough. But if I shut off the communication between the air inside and the air outside (inverting the tumbler), I get a very dull and imperfect sound.

Sometimes the (eustachian) tube [1] or canal, by which this communication is maintained, gets blocked up, in consequence of what is commonly called a "cold in the head," and deafness results. This deafness disappears when the channel is again cleared. I may here give a hint that may be serviceable in certain circumstances. Possibly you have heard that when people go down in a diving-bell they suffer from a painful ringing and tightness experienced somewhere in this organ. That can be easily avoided by the action of swallowing frequently performed during the descent. For this little tube is opened in the process of swallowing. It is ordinarily closed, but when we swallow it is opened and shut every time. The pressure and pain result from the difference in density between the enclosed air and the air in the diving-bell; and the condition of the air within and without is equalised by freedom of communication.

Professor Tyndal, in his book on "Sound," states the

[1] The eustachian tube also serves as an outlet for any excess of fluid in the "drum."

fact to which I am adverting with his usual clearness: "The eustachian tube is generally closed, the air space behind the tympanic membrane being thus shut off from the external air. If, under these circumstances, the external air becomes denser, it will press the tympanic membrane inwards. If, on the other hand, the outside air becomes rarer, while the eustachian tube remains closed, the membrane will be pressed outwards. Pain is felt in both cases, and partial deafness is experienced. I once crossed the Stelvio Pass by night with a friend who complained of acute pain in the ears; on swallowing his saliva the pain instantly disappeared. By the act of swallowing the eustachian tube is opened, and thus equilibrium is established between the external and the internal pressure." [1]

In the space behind the tympanum we find three little bones, called the hammer, the anvil, and the stirrup.[2] The relative position of these bones is subject to some alteration by the action of special muscles. I do not think that I can explain their action with any definiteness. Suffice it to say that they form part of the line of communication. It may be also sufficient to note that by means of this double membrane, forming the true drum, sound-waves are conveyed to the innermost part of the ear, called the labyrinth.

[1] Tyndal on *Sound*, pp. 71, 72.
[2] Malleus, Incus, and Stapes.

This is regarded as the essential part of the auditory apparatus, and it is conveniently distinguishable into three parts: the semi-circular canals on one side, the cochlea (shell-like cavity) on the other, and the vestibule between both. We might lose our way in attempting to explore this labyrinth, and the information attainable is scarcely definite enough to warrant the risk. So I shall content myself by stating that the nerves of hearing dip here into a jelly-like substance, the tremors of which, resulting from the vibrations that have been carried in, are in some manner conveyed to the nerve-centre. It is supposed that the nerves perform two separate functions, according to their respective positions and arrangements. The *vestibular* nerves are said to convey impressions of *quantity* of sound; and the *cochlear* nerves are said to distinguish *quality* of sound. We find at one place a great many thread-like fibres placed side by side with great regularity, and presenting the appearance of a key-board. These are called the fibres of Corti, and it has been suggested that they are like tuning-forks, each having been set to one note, and that their action determines our appreciation of musical intervals. Recent inquiries have not tended to confirm the probability of this suggestion. May I remind you, before dismissing this part of our subject, that sound depends on the vibration of the air. When a bell is rung the vibrations of the metal give rise to air-waves of definite dimension

which we recognise as sounds; but if the bell be placed in a glass vessel, from which we gradually withdraw the air by means of an air-pump, we find that although the ringing be vigorously maintained, the sound becomes fainter and fainter as the air becomes exhausted, until it ceases altogether. When we allow the air gradually to re-enter the vessel, the sound is renewed, and waxes louder and louder.

It seems wonderful—at least it does to me—that by means of these waves of air we have all the ideas communicated to our mind that are expressible, not merely by noises but by musical tones, and that thus also are awakened in us by these tones such a strange variety of emotions; and that undulations of air in the form of spoken words have such power to stir and stimulate thought, and desire, and passion. Much pleasant feeling is stirred in us through the medium of hearing. And to talk of this simply as a mechanical process, that can be explained in terms of matter, has always seemed to me one of the surest evidences of a shallow philosophy.

Over the other gateways of knowledge, Eye-gate may fairly claim pre-eminence. Its visitants come from near and far. Of all the senses it has the widest range. Our examination of it must, unfortunately, be far more brief than its importance warrants.

When we look upon each others' eyes, we notice that they are provided with what have been called

"shutters." These shutters we close at night and open in the morning. Unlike other appliances of the same kind, these shutters are not only used to close the eye and prevent the entrance of light, they are also employed all day long in keeping the windows clean. We are winking consciously or unconsciously throughout the day, and every time we wink we bring down one of the shutters, with a fluid secreted on its surface, to wash the windows and to remove any specks or dust from its surface.

Looking into the eye, or rather looking at it from the side, you perceive that the front part of it bulges out somewhat like the glass of a watch. This, which is called the cornea, serves as a protective window to the eye, and is the transparent portion of a covering that goes round the whole eyeball, called the sclerotic coat or tunic.[1] Standing in front and looking through the cornea we notice a variegated curtain, not a curtain that falls, but a circular curtain that contracts or expands according to the necessities of vision. This is called the iris. Generally some one colour predominates—either blue, or grey, or brown—giving character and expression. Behind this circular curtain, which regulates the supply of light, lies the lens, in which the rays of light are collected and focussed. "We are most familiar with this portion of the eye as it occurs in fishes, looking in the recently-caught creature like a small

[1] From *skleros*, meaning hard.

ball of glass, and changing into what resembles a ball of chalk when the fish is boiled. This lens is enclosed in a transparent covering, which is so united at its edges to the walls of the eye that it stretches like a piece of crystal between them; and in front of it, filling the space dividing the lens from the watch-glass-like window, is a clear transparent liquid like water, in which the iris floats. The lens is further set like the jewel-stone of a ring, in what looks, when seen detached, like a larger sphere of crystal, but which in reality is a translucent liquid contained in an equally translucent membrane, so that the greater part of the eye is occupied with fluid; and the chamber, after all, which it most resembles is that of a diving-bell full of water. Lastly, all the back part of the eye has spread over its inside surface, first a fine white membrane, resembling cambric or tissue paper, and behind that a dark curtain; so that it resembles a room with black cloth hung next to the wall, and a white muslin curtain spread over the cloth. This curtain, or retina, seen alone, is like a flower-cup, such as that of a white lily, and, like it, ends in a stem, which anatomists name the optic nerve. The stem, in its turn, after passing though the black curtain, is planted in the brain, and is in living connection with it." [1]

The lens of the eye is not so convex behind as in front, and it is capable of being adjusted so as to

[1] Wilson's *Five Gateways of Knowledge*, pp. 13, 14.

increase or lessen its convexity according to circumstances; this power of adjustment, however, fails as we grow old. When we look into the eye through the lens it appears dark, because we are looking into a darkened chamber covered with a black wall-lining. This round dark central part of the eye is called the *pupil*, and, as you are aware, it is enlarged or diminished by the action of the circular curtain, the iris.

The iris, however, does not act independently; it takes its cue from the brain. We are consequently able to discover that the brain is injured or inactive, when we find that on flashing a strong light into the eye the pupil remains unchanged, the iris receiving no direction to close the gateway.

It may help us to appreciate the wonderful adjustments of the eye, if we consider what takes place in the studio of the photographer. In the photographic camera we have an arrangement for receiving the rays of light on a prepared sensitive plate. The exactness and definiteness of the picture depends on the proper adjustment of the lens to the position of the sitter: and when there is a large group of sitters it is found impossible to get them all into focus. The operator must manipulate skilfully and carefully to adjust the lens to the position the sitter occupies, so that all parts of the impression may be clear and distinct. So we adjust the lenses of the eye in gaining impressions of differently placed ob-

jects, only not so clumsily. Sometimes the photographer changes the position of the sitter, and sometimes he moves the whole apparatus that he is using. We, standing still, though not always without effort, can adjust the lenses of our eyes to the point of vision that we desire to reach. We do so partly by alteration of the lenses, increasing or diminishing the convexity of which I have spoken, and partly by change in the position of the lenses, brought about by the action of the muscles that rotate the eyeball. We have to remember, however, that any long-continued fixedness of the lens tends to give it a "set;" and we find that watchmakers and others who are constantly narrowing their vision to near and minute objects very materially lessen the range, and impair the usefulness of their eyes.[1]

Then, strangely enough, we find that at the very point where the optic nerve enters the eye there is absolutely no sensibility to light. Every eye has what is called a "a blind spot," and that blind spot is the

[1] Sometimes this lens becomes opaque, and then a "cataract" is said to have formed. In such cases the lens is simply extracted, and thus light again finds access to the retina. Formerly the cataract was *couched*—that is, displaced from its position where it obstructed vision, but allowed to remain embedded in the other tissues. Occasionally a blow on the eye caused this displacement, and in such circumstances there would be the strange result of restoration of vision as a consequence of mechanical injury! Of course, in all cases either of removal or displacement of the natural lens, artificial lenses (spectacles) become necessary to secure definiteness of vision.

spot which of all others would seem most likely to be sensitive to light. A very simple experiment has been devised whereby we may recognise the absence of visual action at this definite part of the nerve.

If on a sheet of paper we mark a cross and a small black circle about an inch and a half apart, thus:

then closing the left eye and looking at the cross with the right, on gradually approaching the paper to the eye, we find that we reach a point at which the black circular mark becomes invisible; on either side of this point it becomes visible again. The point of invisibility marks the stage where the image falls on the entrance of the optic nerve. I need hardly say that this fact does not interfere with the actual usefulness of the eye.

At another point which marks the centre of the retina, we find what is called the "yellow spot," which is most sensitive to light, and which is thought to be chiefly employed in *direct* vision. Microscopical examination of these two spots reveals certain differences in minute structure.

There are two questions often asked that I shall not attempt to answer. How is it that with two eyes, instead of seeing double, we have single vision? And how is it that, although an *inverted* image is thrown on the retina, we see objects in their true position? Are not the needful hypotheses and ex-

planations written in the books of the physiologists? and may you not read there all about the other appendages and actions of the eye?

On the structure and function of all the parts concerned in the operation of the senses our knowledge has been amazingly increased by patient industry and detective instruments; but the very foundation of the bridge that crosses the chasm between physics and sensation remains yet to be discovered. We may tell how atmospheric waves may excite vibrations in various tissues; but how these vibrations are translated into sight and hearing passes our comprehension altogether.

"When I think, indeed," writes Dr. Wilson, "of that large-windowed little cottage which hides under the thatch of each eyebrow, and spreads every moment on its walls pictures such as Raphael never painted, and sculptures such as Phidias could not carve, I feel that it can with justice be likened to no earthly building; or if to one, only to that Hebrew Temple which has long been in the dust. Like it, it has its Outer Court of the Gentiles, free to every visitant, and its inner chamber, where only the Priests of Light may come; and that chamber is closed by a veil within which only the High Priest LIFE can enter, to hold communion with the spiritual presence beyond." [1]

[1] Wilson's *Five Gateways of Knowledge*, p. 20.

VIII.

EVOLUTION AND APPLICATION OF ENERGY.

THERE is a story told of a Highlander who became, for the first time in his life, the happy possessor of a watch. He was never weary of applying it to his ear, and listening to its dulcet sounds. He would not part with it at any price. He thought it such good company that he took it to bed with him. In the morning, when he awoke, his first act was to lay hold of the watch and apply it again to his greedy ear. But alas! it was dumb. It emitted no sound. And our friend, as soon as he found an opportunity, parted with the watch for a trifle, rejoicing afterwards that he had got rid of it satisfactorily, because *it had died last night!*

We are sometimes told that the human body, like a watch, contains a certain amount of energy stored in it after the same fashion, and that it requires to have that energy restored over and over again by a process analogous to winding. We are informed that the human body, like a piece of mechanism, is fitted for performing a certain amount of work, and that energy

must in like manner be supplied to it in order that work may be done.

Now, on the present occasion we have to consider what I venture to call the *executive department* of the organism. We have looked at it broadly as a whole. I have endeavoured to outline for you the different parts of which it is composed. We have studied the "Commissariat," in the "preparation" and "conveyance of aliment;" and as an appendix I have spoken of "the removal of waste and noxious products." Then our attention was called to the "intelligence department;" and we have endeavoured briefly to glance at the "nervous system" and at the "special senses." We may now ask how the body acts; whence hath it the power that it manifests in living and in doing work? We have already learned that the body is developed from a germ; and we have learned also that all living matter comes from pre-existent living matter. In our study of *nature* we do not find any record of the *origination* of life. We cannot tell *how* life began, so long as we confine ourselves strictly to the investigation of *natural* facts. But we recognise life as energy, manifesting itself in various directions.

That I may not be misunderstood, allow me to say that I am not anxious to question current statements as to the present source of cosmic energy. I have no desire to enter the lists against those who maintain that force is centred in the sun, and that its various

manifestations are conditioned by its effluence from that unexplored body. But I remind you, that, in the first instance, going back to the beginning of vegetable life—and I do so because we are dependent on vegetable life for the maintenance of the animal life which we possess—we find that there are necessary, not merely the rays of the sun, meaning by that all that is contained in the force that is streaming from the sun; but also something definite and real on the part of the living plant, whereby it is able to avail itself of this energy, and to build up into its substance the various materials that we find there. Allow me to remind you again that we are really dependent on the vegetable world for the supply of food. Of course carnivorous animals live on flesh; but if we follow far enough back the course of feeding we come to those that feed directly either on the herbage grazed from the ground or on the fruit taken from the plant; so that carnivorous no less than granivorous animals depend for supplies ultimately upon the vegetable kingdom. And the question is, Whence does the vegetable kingdom gain the power to store up in its structure matter in such form as to constitute it available nourishment for animals?

We are told sometimes that this is determined by the *molecular machinery* of vegetables, that it is the molecular machinery of the cabbage or the pear tree, or of any other plant, that determines the particular form that the energy of the sun shall assume within

each individual organism. Now I confess I do not understand these two words, molecular machinery. In the first place, molecules are unknown to us. Sir W. Thomson says that if a drop of water were magnified so as to occupy a space equal to the earth—that is, were it enlarged to a diameter of 8,000 miles—a molecule of that drop would then occupy a space represented by something between a shot and a billiard ball. You can understand how infinitesimally small a molecule must be, when even in the magnifying of a drop of water to this immense extent, a theoretic molecule is so extraordinarily small as this illustration indicates. In fact, it is impossible to detect molecules by any microscopic power we possess; we believe that they exist, because the theory of their existence aids our conception of matter; but to reason from their existence and to base arguments on their mutual interactions, the present state of our knowledge does not altogether warrant. Then I take exception to the second word, machinery. That term has a very distinct meaning. We know what we mean by a collection of mechanism forming a machine or a mass of machinery. We find nothing like that in the living matter of vegetables. We find there, as I have often said, simple, clear, structureless matter that is possessed of the power of motion, and can change other materials that are supplied to it into forms similar to its own. We know of nothing corresponding to mechanism which

can account for the changes that take place within a growing plant. Yet we are asked to believe that by the aid of *molecular machinery* all these differences that are so easily recognised in the vegetable world are produced and maintained. This, however, I insist on as something that cannot be gainsaid, that we do not know that the sun possesses any power—no evidence of any sort is forthcoming to prove that the sun possesses any power—to raise matter from the inorganic state to the organic; to raise it from the condition in which we find it outside the living world into the condition in which we find it in a grain of wheat or any other living organism. In order to this raising from the lower condition to the higher there must be pre-existent life. There must be this vegetal power to avail itself of the sun's rays, to use the energy the sun supplies for the purpose of raising matter from the lower platform to the higher.

Now, in these circumstances to maintain that all life is inherent in the force of the sun, is to leave one of the principal factors in the problem out of account—the life itself—without which the sun's rays are powerless. I have spoken more than once of the transformation of energy and the conservation of energy. And we have heard a great deal about the dissipation of energy. Energy is the power of doing work. That exhausts itself in the performance of the work, and is thereafter to be sought under another form.

I admit, without questioning, all that is said by physicists in regard to this subject—the conservation of energy, and in regard to the other subject—the dissipation of energy, although I confess—probably it is because of my own dulness of comprehension—that I am unable to attain that measure of conviction and certainty in regard to some parts of these subjects which others seem to have reached. But I do not intend to contest any of the deductions that are prevalent in connection with this doctrine of the persistence of force, or that other doctrine of the gradual dissipation of force. You can find fuller information in regard to this matter in Grove's book on the *Correlation of Forces.* Professor Tyndall has published a lecture on *Force*,[1] in which, with some things to which I certainly object, there is a very large amount of valuable information. Perhaps a still more elaborate and satisfactory discussion of the subject may be found in Professor Tait's lectures on *Recent Advances in Physical Science.*

But without questioning or entering into any dissertations on force, I would suggest two cautions that to my mind seem to have considerable weight. The first is, that we are not to suppose that when it is admitted that there is a certain amount of energy existing in the universe, and that this amount of energy cannot be lessened or increased by anything that we

[1] Tyndall's *Fragments of Science*, vol. i. p. 421.

do, we are not to suppose that we have accounted for energy itself. Let us go back as far as we possibly can, not merely in history, but in thought, and let us endeavour to form a conception of *how* it was that energy came to exist within the bounds of this universe, and we will find that we cannot possibly account for it. The only admissible explanation seems to be that it was originally communicated (and indeed that it is still maintained) by some dominant will. I do not press this as a proof; but I contend that it stands alone as a rational theory. Science, at all events, is confessedly unable to account for the introduction, the origin, of energy. The question as to its beginning is one that cannot be answered; it is a problem insoluble by science. I know that it has been suggested that the great central source of energy, the sun, gained this power by the clashing together or coming together of a great many atoms of matter; and it has been suggested that the power in the sun may still be sustained by the falling into it of certain bodies, and by the force developed by their impact on its surface. It has been calculated that if we had a mass equal to the sun's mass, composed of the most combustible elements possible—those chemical elements from which the largest amount of heat can be evolved—we would only gain from its combustion a sufficient supply of such heat as we now have to last for 5,000 years. Consequently, as the sun has been giving a supply, according to the doctrine

of geologists, for a great many thousands, not to say millions of years, evidently this large supply cannot have been produced by the *burning* of any *known* substance equal to the mass of the sun itself. A mass of the most perfect combustibles we know *falling* into the sun from the earth's distance would yield an amount of energy equal to 6,000 times the resultant of its combustion. This, however, is *theoretical* explanation, fairly enough adduced, I admit, to account for the *supposed* fact; but even if it were demonstrated science it would not settle the question of the primary evolution of energy; it would only remove the investigation one stage farther back.

And this is the second caution. While I admit that I cannot lessen or increase the amount of energy existent in the world, and that no other person with whom I am acquainted has been able to increase or lessen it, I am not prepared to allow that it is *impossible* so to increase or lessen the amount of energy existent at any time. I believe that something came into the world that did not exist in the world previously when *life* began. I believe that something came into the world that did not exist in the world previously when *animal life* began. I believe that something came into the world that did not exist in the world previously when *rational life* began. Whether you can express these things in terms of motion or matter or not, these are things—powers I venture to call

them—that began to be, in a definite time, and they are real additions of some sort to the amount of existence and force on our planet. And if I believe, as I do, that there once lived on this earth a Man who could raise the dead, *then* there existed even on this planet power that could *give* energy, a Power that could impart force though we cannot, and that *could* have added in many directions, whether He did so or not, to the amount of energy existing in the world. And no one can deny that the Lord Jesus Christ *did* introduce into the world a real power, whether we call it spiritual or not, that is as fresh and inexhaustible to-day as it was 1800 years ago. And although this power has not removed material mountains, it has delivered men from spiritual death, and made them "a new creation," qualifying them for doing deeds that were else impossible, and imparting to them another and higher life that nature can neither communicate nor explain.

I think it needful to give these cautions, because I quite apprehend the readiness with which any admission in regard to the amount of energy existing in the world—specially its persistence and unalterableness—might be used as an argument against the supernatural facts with which we, who are accustomed to read the Bible, are conversant. Indeed, John Stuart Mill admits that a miraculous event would not infringe the law of causation. In that case, he alleges, there would be pleaded fairly "a direct interposition of an act of

the will of some Being who has power over nature;" and, he adds, "of the adequacy of that cause, if present, there can be no doubt; and the only antecedent improbability which can be ascribed to the miracle is the improbability that any such cause existed."[1] The truth is, if we admit the existence of the supernatural at all, we must recognise forces that are beyond the reach of physical science. Still, with these reservations, or rather, giving these cautions, I am ready to admit generally that the amount of energy in the world is fixed. I am ready to admit, further, that in an animal body such as ours a great part of the energy, at least, that we use—the greater part, perhaps the whole—is derived from the various foods that we assimilate. It would be rash to affirm that we find here an exclusive explanation of all the facts connected with the functions of the human body. For, if you remember, there are such things as bioplasts. We have made their acquaintance formerly, and we have not forgotten them. And when we talk about the food that we introduce into the body, and the oxygen that we receive into our lungs, and about all the actions that are carried on within the organism, we cannot forget that these bioplasts have a very intimate and peculiar connection with the whole process. We have, just as in the case of vegetables, this life conditioning the whole result. Therefore I object to saying

[1] *Mill's Logic.* Book iii. chap. 25, sec. 2.

that we have only chemical processes within the body, or that we have only mechanical processes, along with chemical, manifested in the human organism. We have something more and something other. And when we remember, moreover, that the bioplast precedes the food, we have a fact that qualifies our whole study of the subject. The bioplast is there in the first instance. In the case of the first life, the bioplast was there before the food: it was there to receive the food and to use it. And to leave out of account the fact that it is by means of this bioplast that the pabulum is made available, and that it is only made available by being transformed into its own likeness—taking on its own bioplastic character in living succession—to leave this out of account is to leave out a most important and essential fact in the whole history of life. It is the play of Hamlet, with Hamlet left out.

If it be remembered that we have food *plus* life, I have no objections further to offer to all that can be said in regard to the use of food for the maintenance of the animal, and for all the purposes to which force or fuel may be applicable in an ordinary machine. Nevertheless it is right to add that, although we can determine *quantitively*, in arithmetical figures, the amount of work done as related to the amount of fuel supplied, in such a mechanism as the steam-engine, and can carefully and exactly measure both, we are

not able thus exactly and *quantitively* to determine the relation between the food we introduce into the body and the amount of work that is done in the body itself. Indeed, we get into a new region entirely when we study living processes; and there is no subject that will give you more hesitancy, and on which there is greater uncertainty, in the writings of the best authors. It is extremely difficult to determine the relation between the food supplied and the work done. The reason is simple. We cannot follow the food in all the processes through which it passes, nor can we see the actions that take place in the whole current of the circulation through the body, or the decomposition of material or tissue afterwards in the production of the force that the body manifests. We must not suppose that there is anything like the same certainty or knowledge in regard to the transformation of food into animal force, that there is in regard to the transformation of fuel, in such a mechanism as the steam-engine, into the force that carries it along the rails and drags a number of waggons behind it. It is therefore misleading to argue as if the two transformations were identical.

Allow me to say here that it is admitted, looking at the human body as a mechanism for the production of forces, that it is the most economical mechanism that we know. It is certain that you can get far more from a ton of hay eaten by a horse than by its com-

bustion in the furnace of a steam-engine. And Helmholtz has made the calculation that only one-tenth of the fuel we use can be made available for mechanical work in our best machines; whereas the body can convert one-fifth of the power contained in food into an equivalent of work.[1] The living mechanism—I use the word freely because you cannot misunderstand it after my explanation; I do not like the word, but it is convenient—is so wonderfully complete, that we can, with the least possible loss, get from the food a very large amount of force. We have to take into account, in speaking of energy, that the body manifests not merely such power as is exhibited when I stretch my arm, or strike the table, or walk from one point to another. These are external manifestations. But there is energy expended also in the action of the brain, in the beat of the heart, in the expansion and contraction of the lungs, in the secretion carried on in the stomach and liver and in all other glands. Besides, there is continuous evolution of energy in

[1] We must distinguish, however, between economy of *force* and economy of *cost*. Letheby, in his *Cantor Lectures on Food*, says (p. 109):—"Taking a steam-engine of one-horse power (that is, a power of raising 33,000 lbs. a foot high per minute) it will require two horses in reality to do the same work for ten hours a day, or twenty-four men; and the cost would be 10d. for the steam-engine, 8s. 4d. for the two horses, and £2 sterling for the twenty-four men."

Donders has pointed out that the worst and most extravagant use you can make of a man is to employ him exclusively in mechanical work.

continually maintaining the temperature of the human body, which ranges between 98° and 100° Fahrenheit scale, with slight variations. As we know, heat is the outcome of energy, or rather, as is commonly stated in the present day, heat itself is a mode of motion. I presume that you have read or heard of the discovery made by Mr. Joule, of Manchester, as to the equivalent of heat in mechanical motion. He demonstrated that the exertion required to lift 772lbs. one foot high, or one pound 772 feet high, is exactly equivalent to one degree of heat on the Fahrenheit scale; or, conversely, what suffices to raise the temperature of a pound of water one degree can, acting otherwise, raise 772lbs. one foot in height.

The maintenance of animal temperature consequently indicates a very large expenditure of energy. For in the coldest regions, just as in the hottest—at the poles no less than at the equator—the human body maintains very nearly the same temperature. The Esquimaux and the Indian alike have a temperature ranging between 98° and 100°, and this temperature is sustained by the evolution of power from food available and applied to the production of heat. There are some terms employed in regard to this subject that it may be useful for you to remember. You will read in books about potential energy and active energy —energy of *position* and energy of *motion*. I shall endeavour to give you in very simple language an

explanation of what these terms mean.[1] Suppose we have 20lbs. of water lifted from the sea by the heat of the sun's rays. These 20lbs. are lifted up in the form of vapour, and they float in the sky at a certain height in the form of clouds. Then, through some alteration in the temperature, these clouds condense, and the contents fall as drops of water on the top of one of our highest mountains. In falling, these raindrops give out heat. There is heat given out in their condensation; but leaving that out of account, they give out heat when falling on the mountain summit. Then they give out heat as they roll down in the mountain torrent, and as they flow down in the stream or river until they reach the sea. It has been calculated that in the course of their descent from the cloud there is just as much heat given out as there was heat expended in raising them up in the form of vapour. The same amount of heat is evolved in their descent to that low level that was required to raise them to that high level. Take a more familiar instance. Two men are employed in raising a heavy weight until it reaches the height of twenty, thirty, or forty feet. When it has reached that height, by a special mechanism it is detached, and falls upon a pile fixed in the bed of a river. There is just as much force given out in its fall as

[1] For a clear and complete exposition of the "Doctrine of Energy," the student should consult Dr. Balfour Stewart's excellent little treatise, *The Conservation of Energy*.

there was expended in raising it up to the height. The force of its fall measures the force expended in raising it up to the height from which it fell. So in certain chemical combinations there is an amount of force stored up, and in the decomposition of these chemical substances there is as much force given out. We are all familiar with the fact that gunpowder explodes. By its explosion in a closed tube it is able to send a cannon ball or a rifle bullet with a certain amount of velocity to a definite distance. We have the force or energy stored up in the gunpowder communicating velocity to this ball or bullet. And we have the exact measure of the force in the gunpowder—taking other circumstances into account—determined by the velocity, the weight, and the distance. Now I suppose you are aware that gunpowder is a combination of nitrogen, carbon, sulphur, and oxygen. And in these nitrogen is the particular element which, apparently from its instability of chemical combination, is most available for the liberation of energy. We are familiar with the fact that cotton—a very innocent thing—when steeped in a nitrous solution, becomes tremendously explosive in the form of gun-cotton. A spark can at once set free its energy for the purposes to which we may wish to apply it. There are some substances that are even more easily decomposed, and from which we can liberate energy with more readiness than gunpowder or gun-cotton. For instance, chloride

or iodide of nitrogen, which a touch is sufficient to explode.

I allude to these things to illustrate the fact that in the materials of the body we have stored up a certain amount of energy that, because of the peculiarity of their chemical combination, can be readily liberated within the body for definite purposes and for definite work. You are aware that we take a very large amount of nitrogenous food—we are not forgetting the importance and value of carbonaceous food—and it is, to a large extent, these nitrogenous constituents that are serviceable within the body, very much after the same fashion that nitrogenous compounds are available outside the body for the evolution of force. Mr. Herbert Spencer, in his book on *Biology*, insists very strongly, and I think very fairly, that we have in the nitrogenous alliances a very large amount of force or energy stored up that can be liberated *readily* and *easily* for the doing of work. How the various elements are combined in the body, and in what precise circumstances they are usefully decomposed, has not been at all definitely ascertained. It was at one time thought that muscles, for instance, in being exercised are decomposed, and that by the destruction of the muscle the power of doing work resulted, that every time I strike the table, or walk from one point to another, muscular tissue is consumed in the production of motion and heat that follow. But Mayer has

given good reasons for supposing—and his conclusions have been strengthened by subsequent experiments—that it is not by the decomposition of muscle, but by the supply of blood to the muscle, that force is evolved.[1] I am not going to enter upon that matter; I wish merely to call your attention to the fact that, although we know that different substances are capable of being decomposed, after they have passed through living processes within the body, we are not able at this moment to say, exactly, in what precise circumstances this destruction of compounds takes place for the liberation of force. Still, we know that it is by the falling of this compound down to a lower level—if you will allow a metaphorical expression—that we have force produced. As by the falling of a mass of water (raised by the sun's rays from the level of the sea) down from the mountain top to the level of the sea again, a large amount of work may be done—a great amount of solid material carried down, many mills turned, and a great many useful mechanical purposes served—so in the falling down of chemical compounds from the high condition which they have reached in combining, to a lower condition, a large amount of power may be given out that may be turned to useful purposes, such as the production of heat, or the performance of work.

[1] Mayer in 1845 maintained that "a muscle is only an apparatus by means of which the transformation of force is effected; but it is not the material by the change of which the mechanical work is produced." He regarded the blood as "the oil in the flame of life."

I think I have said enough to explain how, according to our present knowledge, we believe that this energy is liberated within the body. It comes from the transference of this matter, in the higher condition to which it has been raised through the processes of life, down to the lower condition in which it ceases to be serviceable for the interests of the body, and is either turned out of the body or is sent back in the current, to be again submitted to a similar process that will raise it up anew to the higher condition that it may fall another time. So that, in a real sense, stores of energy are supplied to the body from day to day. The body is *wound up*, metaphorically, by the food that we take; the body may be described as being fed with fuel, like the furnace of the steam-engine. Only, in addition to what I have already said about bioplasts, and about the action of life generally, there is this to be taken into account: that not only are these materials raised up to a certain condition before they are available for us, but they are raised still further within the body by the processes to which they are subject in the organism itself. I have seen the matter put in this form. Suppose we have three steps or platforms: a lower representing inorganic material; a second, say a foot higher, representing the vegetable plane; and a third, a foot higher still, representing the animal plane; then from the highest platform the fall of a body down to the lowest, of course, developes more force than the

fall of a body from the middle platform to the lowest. The fall of a body from the height of the table is of course productive of more heat, by its impact with this platform, than the fall of a body from half that height; that is to say, there is more potential energy (energy of position) in a body placed higher up than in a body at a lower level; there is more energy that can be exercised, and is actually exercised (energy of motion), when it falls. The potential energy is that which it has when raised up, like a mass of matter on the table, or like the rain in the clouds. The active energy is that which is manifested in its fall to the lower level. From whatever source it may be derived, it is evident, from the organic processes to which it is subjected, that all the food we take is raised to this highest platform, and so made fully available by energy of position for evolution of energy of motion. When it is so raised, we set it free by means of nervous action. I explained that on a former occasion. The nerve-cord conveys the impulse causing the muscle to contract. The power is developed in the muscle, but the stimulus that determines the exercise of this power is conveyed by the nerve from the nerve-centre.

Here we are confronted with another question. Whence does the impulse ultimately issue? If I will to walk or raise my hand, of course the nerves stimulate the muscles, and they obey, and energy is liberated. But whence, first of all, comes the force, impulse, in-

tention—call it what you will—that, carried by the nervous system, sets free this energy? A plain man will answer, "From myself." Interrogated further, he will explain that he means from his mind or will. And our wisest scientists cannot say anything other, or more profound. Some, indeed, affirm that this is poetry, but I maintain that it is the simple utterance of conscious fact, which is as real to me as any fact can be to which my senses testify. I know that, if I wish or resolve to perform any action that is within the limits of my capacity, so soon as I have formed the wish and determined the deed, the deed is done. There is a bridge crossed immediately between this intangible thought or purpose in my mind, and the brain or nervous system whereby the material framework in all its parts is governed and controlled. And it is impossible to talk of this command issuing except in terms that personify. Our most determined materialists are betrayed into talk of engineer or driver, or director or somebody else at the head of affairs that gives impulse and counsel, and determines all the subsequent action. They must poetise. They cannot escape the practical, powerful influence of consciousness, whereby they are inexorably reminded that there is behind and above the brain a mysterious power that bridges over the gulf between itself and matter, and acts effectively on the organism for the promotion of such ends as it may desire to reach. The laws and limits of thought and

language *bar even the statements* of a consistent materialism.

> "Strive to expel strong Nature, 'tis in vain;
> With double force she will return again."[1]

[1] "Naturam expellas furcâ, tamen usque recurrit."—*Horace.*

HEALTH STUDIES.

FOOD AND APPETITE.

THERE is an old Greek story about a simpleton who endeavoured to gain, from a beast of burden, serviceable force at the least possible cost. Desirous of saving expenditure, he gradually reduced its supply until he brought it down to a single straw per day. To his great astonishment and sorrow, when he had succeeded in perfecting this valuable economy the animal died! We do not need to be told that if we would get work from the body, we must give it food, and the amount of work we get is measurably proportionate to the amount of food that is given. We need not go to school to learn that the animal body is incapable of existing without continuous nourishment. There are many stories on record of fasting men and fasting women, but these are regarded with great suspicion by those who have studied the science of life. One notorious case is fresh in the memory of most of us, that of the Welsh fasting girl, whose parents told us that she had been altogether without food for many long

weeks; but she only survived a few days after being subjected to systematic inspection. There are some puzzling cases, we admit, concerning which we are slow to give judgment; but, speaking broadly, we are convinced that, although the human body, in certain exceptional circumstances, may survive a long time with a very limited amount of food, yet it must have *some* food continuously supplied. We know, indeed, that there are some hybernating animals. These go to sleep in the beginning of winter, and they remain in a dormant condition till the time for awaking comes round. When they enter upon their winter sleep, they are sleek and fat; when they emerge from it, they are lean and feeble. They have lived upon a certain amount of food, in a prepared condition, stored up within their bodies. And perhaps we may not yet be able to predicate exactly, to what extent, and for how long a time, in some conditions, men and women may live upon food similarly stored up in the body. But we are sure of this, that so long as life continues there must be expenditure of material. And the experiments of Mons. Chossat have shown that when the animal loses two-fifths of its own weight it dies.

There is a very interesting case with which those who have read books on diet cannot fail to have made acquaintance. Louis Cornaro, an Italian, at the age of forty, after having lived very freely, was

reduced to poverty by the misconduct of his friends. From that time he began to regulate his life after a very strict fashion. He succeeded in reducing his daily allowance of solid food to twelve ounces, and ultimately he was able to subsist on an egg daily as his only solid food. At the age of eighty-three he wrote a book on "The Method of Attaining a Long Life," in which he urged this ascetic abstinence as the best provision for attaining that result. He died at the age of ninety-eight. Watchful throughout the whole period, with special care he calculated painstakingly the amount of food that seemed absolutely needful, and lived by weight and measure. Others have followed in the same direction, and they tell us that if we would perfect our physical condition and duration, we must not fail to determine rigidly the exact amount of solid and liquid foods that we ingest. Montesquieu, I think very fittingly, remarks that life regulated after that fashion is only protracted disease; and indeed, I confess that it would be a very great hardship if we were obliged to consider, every day, the amount of food, the kinds of food, and the varieties of food that we should take, in order to maintain our body at a certain minimum or maximum vigour. Happily, we are saved all this trouble. We need not purchase a pair of scales; nor need we qualify ourselves to make chemical analyses. By that instinct or faculty that God hath implanted in us

called appetite, we are able to determine within reasonable limits what amount of food and what kinds of food we ought to take.

Now, let me be guarded here. I mean, when I speak of *appetite*, something very distinct from what are commonly called *tastes*. Tastes are not to be depended on, in this city or in this century at least. Tastes are very various, and, unfortunately, in our time and country, are in man cases very vicious. But appetite, which means natural relish and desire —the normal wish and want that God has implanted in us—is a very fair test both of the amount and of the quality of food that we should take. And let me say, it is most important that we should maintain this instinct or power that we call appetite in its pristine simplicity and in its pristine sensibility. We know that other animals determine for themselves, with wondrous accuracy, the *kinds* of food they ought to take, although I suppose they sometimes err in *quantity* as some wiser animals do. I think that there is fair reason for believing that this faculty of selection ranked among the endowments of man in some purer and higher condition. There are striking evidences of its existence discoverable still. But, unfortunately, in many cases it is sadly defective, even in unsophisticated childhood, and the subsequent course of life tends in many instances to weaken it still more. On the other hand, this instinct has a remarkable resi-

liency, and at times, and in spite of perversions, it gives forth no uncertain sound, and even in cases where tastes are most perverse there is enough left of this faculty to give warning at least, and to indicate over and over again what ought to be avoided. There are punishments—I had almost said, Thank God there are punishments—to warn us when we have gone astray. God hedges our way with thorns, and it is after that fashion He disciplines and checks us. When we will not be allured by pleasure, He sends pain to turn us from the wrong path into the right. Pleasure is God's great instrument—not pain. Judgment is His strange work: He delighteth in mercy. This is true in animal life as well as in mental or spiritual life. God has very closely associated the natural and right exercise of our faculties with enjoyment. The best of sauces is hunger; unperverted appetite yields the keenest relish: and when we maintain appetite pure and undefiled, we are best prepared to enjoy food and to turn it to good account with the greatest ease and success. I venture to speak emphatically on this subject, because I believe that there is no better guidance attainable than that which is afforded in the possession of this simple, common instinct. When we have to diet or care for large bodies of men, as in prisons; or when we have to supply provisions to armies in the field; or when we have to arrange supplies for varieties of condition in

hospitals, then we must be guided to a large extent by the results of scientific investigations. But for our personal use and personal guidance there is nothing better, if we maintain it in anything like its pure condition, than our own individual appetite. You will get no rules from books, and no lessons from science, that you can substitute for the guidance that a healthy and unperverted appetite will freely and always give.

Of course, it is not difficult to tell, by chemical analysis, what the body is composed of. We can take the human body—after death, of course—to pieces; we can break it up into its component parts. As we have already learned, we find it is mainly made up of these four elements: hydrogen, oxygen, nitrogen, and carbon; with sulphur, phosphorus, iron, and a few other elements in smaller proportions. And it is an easy inference that, for the maintenance of the body, so constituted, it must be supplied with certain quantities of hydrogen, oxygen, nitrogen, carbon, sulphur, phosphorus, &c. There is reason in such a statement as that. The elements that are in the body are the elements that must be supplied to the body, if we would maintain it in full health and working power. Then, besides, we may measure the amount of waste, the sum of the various substances that are thrown off from the body day by day. Very careful methods have been employed to ascertain precisely the amounts of hydrogen, oxygen, nitrogen, carbon, and other elements

that are thrown off by the human body daily under varying circumstances. Taking an average of the amount of this daily loss—the waste of the body—we may say, fairly enough, that the food supplied must compensate for this loss by containing equivalent amounts of the elements expended. We have to remember, however, that we cannot supply these elements in their simple, uncombined condition. You cannot take hydrogen, or carbon, or nitrogen, or sulphur, individually and separately, for purposes of nutrition. We must obtain these elements either from animals, in the compound form of flesh, or from plants, in the compound forms in which they are associated by vegetable life. These elements must be built up into certain available forms before we can use them for nourishment. And, more than that, there must be a fitness of relation between these compounds and our organism, otherwise they will not prove serviceable for the supply of our wants. There are large quantities of nitrogen in certain poisonous plants; but if we take nitrogen in such forms, instead of maintaining life it will arrest and destroy it. Nay, these elements may be supplied even in a generally nutritious form, and yet, because of some peculiarity of constitution, they may prove hurtful in no small degree to certain individuals. There are persons to whom substances that are ordinarily highly nutritious are positively injurious. Such persons have what are

called idiosyncrasies, or peculiarities of constitution, that prevent them from making a safe use of these materials. Then, besides, at different times the same individual may be unable to avail himself of useful articles. At one time he may be able freely to eat of certain substances and find them useful in a very high degree. At other times if he partake of them, even to a limited extent, he suffers in consequence. When I go away to the Highlands for my holidays, and live in the open air all day, I may eat freely anything that is set before me, asking no questions for my stomach's sake; but during my working days and nights I am. rather more careful as to what I eat. I have learned, as every one does who is not either supremely vigorous or supremely foolish, that there are some kinds of food more easily assimilable than others, and that there are other kinds of food that are not readily digestible, and that do not conduce to clearness of thought and activity in work. So there are people who, in certain cases, either of work or disease—in cases where they have to do certain duties, requiring careful and exact consideration and concentration of mind, or in cases where there is some weakness, it may be of the stomach, it may be of the liver, or of some other organ—are obliged, on that account, to be very careful as to what they take, and to regulate their diet accordingly. There is an old saying, and it is a very significant one, that "every man is either a fool or a

physician when he is forty years old." That is to say, he must have learned by that time, from sad experience, that there are certain things he ought not to do, and certain things he ought not to take; and he will prove himself a fool if he neglects the warnings, and a physician if he profits by the lessons. We ought to learn by experience. "Experience is a good teacher, though the fees are heavy." And, as I have said, there is no other equally serviceable method of guiding ourselves in questions of food and appetite.

I have now to tell you that foods are divided into certain classes, and these classes have certain distinctions that are easily remembered. Take this division, which is quite as helpful as any other. Foods are divided into PROTEIDS, AMYLOIDS, OILS or FATS, and MINERALS. PROTEIDS are recognised as containing nitrogen. Perhaps we can understand this subject better by adverting to Liebig's theory, even though we do not accept it. Liebig taught that all foods are divisible into two great classes—flesh-forming and heat-giving; all foods either form the solid structure of the body, or are consumed in yielding useful heat. The one class he called "plastic," and the other class he called "fuel." We can easily understand a division like this; it has the great merit of convenience. But, unfortunately, it has not the greater merit of truth. For a great many of these substances said to be flesh-forming yield heat, and a very large number

of those articles that are said to be heat-giving are used in building up structures in the body. For instance, there is in muscle, which is strictly employed in doing work within the body, a certain amount of fat that is just as essential to its muscular integrity as fibre. And yet fat, according to Liebig's classification, is distinctively a heat-giving food; but without fat you have no muscle; it is essential to muscular completeness and activity. A very large amount of brain tissue is simply fat in one of its forms. The brain is an organ that is employed only in doing certain work, and that is not probably to any appreciable extent used in giving heat by its decomposition, yet it is largely composed of this element of fat, which Liebig classes simply and purely as a heat-giver. Still this division, which was very widely accepted when proposed by Liebig, has been the means of suggesting inquiry; and it has also been helpful in directing the attention of those who have examined the subject minutely, to certain corners and quarters to which, perhaps, their attention might not otherwise have been called. Nevertheless, on the other hand, if we divide foods into nitrogenous and non-nitrogenous — those that contain nitrogen and those that do not—we have a chemical division that is useful and true. The PROTEIDS, among which we find *albumen* (white of egg, seeds of wheat, and other cereals), *fibrine* (lean of meat, also in cereals,

juice of the grape, and most vegetables), and *caseine* (cheese, pease, beans, and other leguminous seeds), all contain nitrogen.[1] The AMYLOIDS,[2] or starch-like foods, such as starch, sugar, gum, &c., contain no nitrogen. The OILS of different kinds which are of the same character as FAT are rich in carbon. Then as to MINERALS—what would you think is one of the largest constituents of the body, and one which we must class among the minerals? Certainly it cannot be classed as nitrogenous, or amyloid, or fat. It is allied entirely to the mineral world—WATER. Then besides water we have salts of different kinds. We find common salt, which proves useful in the stomach. Phosphate of lime is also largely present as a constituent of bone.

Well, there are these four kinds of food, and we must take them in fair proportions ordinarily in order that the body may be maintained in vigour. Certainly for full healthy life they must be all freely supplied. Now if I had to measure the amount of nitrogenous food and the amount of carbonaceous food, and take these exactly in proportion to the body's wants, it would be a very troublesome task. I should have to spend the greater part of my life in making analyses and determining these things for myself. But

[1] The nitrogen is not alone; it is in combination with carbon, hydrogen, and oxygen, and some other varying elements.

[2] From two Greek words, *amylon*, starch; *eidos*, form—starch-like.

we are not placed under any such necessity. There may be times, in the case of certain diseases, when some elements require to be avoided and some other elements require to be supplied; and then a wise physician may prove very useful in determining, by weight and measure, what to give or what to withhold. But in ordinary living we are freed from this necessity, because our natural appetites class and combine these elements in fair proportions day by day.

Let us take, for instance, the food provided for infancy—the milk that every child gets from the mother. I have been lecturing in a great many Board Schools, and I very often ask the boys and girls—those in the advanced standards, not the little ones—this question: "What was the first food you ever got?" Almost invariably the answer I receive is, "Bread." Of course they ought to say "Milk." I have to remind them that we all begin as babies. A baby is a very active little animal; it kicks and crows and moves its arms about freely; and it thrives remarkably well, and grows bigger and fatter on this simple food alone. Milk supplies the babe with all the elements needed to make it grow. It grows a great deal more in a year than any of us are likely to do in the course of this year. Now when we analyse milk we find that it contains all the essential elements of which I have been speaking properly combined for

the infant's food. We find it has 873 parts in the thousand, of water. And you remember that water plays a very important part in the body. It is by means of water that all the different parts are kept soft, and all the different elements are carried from one place to another; it is the great circulating medium within the organism.[1] Then milk contains 48 parts of caseine, or cheese, which is nitrogenous matter—one of the proteids containing nitrogen. It contains 44 parts of sugar; it has 30 parts of butter or fat, 2·30 of phosphate of lime, and 2·70 of other salts. So that in milk we have all the requisite elements—the proteid in the caseine, the amyloid in the sugar, the fat in the butter, the mineral in the salts and in the water—and all combined in the very form in which they are best fitted for supplying the wants of the child.

I do not mean to say that milk is sufficient food for grown-up people. What may be good for babies may not be good enough for men. We have good authority for that: "Milk for babes, and strong meat for those that are of full age." Still we have here a typical food that indicates the natural arrangement of the different classes of foods that are adapted for those of maturer years. It may be asked: While it is true that we have these elements supplied in the case of children, have we any such provision made, otherwise,

[1] *The Human Body and its Functions*, p. 78, *et seq.*

for our wants when we become older? Yes, thousands of such provisions. We have provision made in every country under the sun, and I believe provision adapted to the wants and necessities of different climates. Men everywhere are supplied freely from nature—from the world in which they are placed—with all the elements rightly combined that are fitted for the nourishment of their bodies. We heard, not long ago, of many in Ireland—it was particularly brought home to our hearts during the former famine—who lived on potatoes and milk and butter. We have heard the old joke about an Irishman's dinner being "potatoes and point." A rasher of bacon hangs in his cabin, and when he eats his potatoes he points them at the bacon to give them a relish! The potatoes with butter, or fat of any kind, however, really served him, and, along with the milk, supplied all his wants pretty fully. We find in the potato a large amount of starch, and also another glue-like substance called gluten.

Let us take bread, as giving us a better illustration, and one with which we are more familiar. Bread is commonly called "the staff of life." I believe we can maintain our bodies in full vigour for a long time on bread and milk, if our digestive organs are in a normal condition; but there are some persons who, from defective digestion, are not capable of thus using milk and bread. This would not hold good in

their case, but in ordinary cases, especially if the bread have a little butter spread on it, we could on this diet maintain our bodies in active work for a very long time. But while it is true that the various serviceable elements may be supplied in these forms, there is another thing to be kept in mind. As I have already said, there are peculiarities of constitution, or state, that make us unable to profit by the particular form in which nutriment may be assimilable by others.

Analysing bread, as we have analysed the potato, we find that it contains starch in large measure, and starch is a carbonaceous food. It is converted in the body into dextrine, in the first instance, and ultimately into sugar, probably sometimes into fat. This has been a question much debated, but I think evidence has been adduced to show that saccharine substances are capable of conversion into fats. For instance, bees have been fed on nothing but sugar or honey. Yet they have made wax, which is a fatty substance—that is to say, they have transformed the saccharine matter into fatty substance. And those unfortunate fowls that are shut up in darkness and gorged with food that they may have enlarged livers, are fed on starchy foods, and convert these into fatty material. We have reason to believe that these starchy or saccharine matters are convertible into fat within the system. What the process may be we are not able to determine, but as to the effect or result

there can be no doubt, after the experiments and observations that have been made.[1]

Well, we have starch in bread. We have also the other substance of which I have spoken, found also in the potato, called gluten, a sticky glue-like substance. There are some wheats that are exceedingly tenacious, because rich in gluten, such as the wheats of Italy, from which macaroni is made, and drawn out into those familiar long tubes. Now gluten is of precisely the same character as the fibre of muscle. It contains 15½ per cent. of nitrogen. And we have to learn this, for it is important to keep it in mind, that these nitrogenous substances, of which Liebig spoke so much, and of which so much is said still, are not derivable only from the animal world. We have to remember that many vegetables contain as much nitrogen, and they contain it in a form as assimilable and as useful in the body for its purposes as animal food. Gluten contains precisely the same amount of *nitrogen* as the fibre of muscle—15½ per cent. So we have these two substances in wheat, the amyloid and the proteid or nitrogenous. Then we have certain minerals in wheat. And specially in oats we find at least one of these minerals in very considerable proportion. I have read in certain advertisements that wines of a particular vintage are very good for brain-workers because they contain a

[1] Foster's *Text-Book of Physiology*, p. 318. Macmillan, 1877.

large amount of phosphates, and people are recommended to drink them on that account. If any one wishes to get phosphates in much fuller amount, and in a much safer condition, I recommend him to try oatmeal; he will get the phosphates there without the alcohol, which is a poison, and he will get phosphates in combination with the nitrogenous elements of which I have spoken—starch and gluten—that are useful for sustaining physical activity.

I do not wish to detain you longer with these details of chemical analysis, although it is desirable to keep them in mind. In practical life we do not really need to trouble ourselves very much about them. It is a good thing to know that we require a certain amount of nitrogenous food, and to know that certain substances used as food contain these in certain proportions. And it is peculiarly useful for medical officers who have to make provision for feeding large masses of men, because they are thus guided in choosing economically the foods that are on the whole best adapted to their purpose. But for our own special and individual use we do not need to trouble ourselves very much about these things. At all events, we do not need to know, or remember very carefully, the names that are given to them. The wants of the body are generally indicated with sufficient exactness by natural appetite.

It is strange that, although a great deal has been

done in attempting to discover the *cause* of hunger, we have not been able to determine it up to the present time. The old theory was that the stomach got empty, and the walls began to grind against each other, and the grinding made us feel pain until we put something in to separate them! A later theory, started, I think by Dr. Beaumont (who has done so much in the sphere of gastric digestion), was, that when the stomach began to form gastric juice, the vessels in which the juice was prepared were distended, and their distension produced sensation in the nerves of the stomach, which sensation gave the feeling of hunger. But why does not the gastric juice come out rather than distend the vessels, since the mouths of the tubes are open? The truth is we do not know exactly how hunger is caused. We have a sense of sinking and want, sometimes of actual pain; and if we go without food for two or three days we have intense pain. The feeling is in the nerve-centre, although it is referred to the stomach; in the same way thirst is referred to the back of the throat. The probability is that hunger and thirst arise from the want of food and drink throughout the whole system. For without putting anything into the stomach, we can allay the sense of hunger by injecting prepared nourishment into the vessels. Strangely enough, we can stop it also for a time by putting non-nutritious substances into the stomach. Some people alleviate hunger by

eating clay, and it is no uncommon thing for sailors who are shipwrecked and suffering from hunger, to allay this feeling by chewing tobacco. It can be allayed also by alcohol. Anything that dulls or deadens the nerves of the stomach, or the nerves of sensation generally, has the effect of lessening this feeling.

Speaking practically, this feeling of hunger is a dinner-bell to tell us when we ought to eat, and it is the best dinner-bell that any of us can hear and obey. This question is frequently asked: "How often should I eat?" Well, the answer can be given to some extent by determining the length of time that is taken to digest the food. We find that this varies from three to five hours; it depends very much on the kind of food, and also on the kind of stomach into which it is put; so that no exact time can be assigned as invariable. It would be very difficult, without full previous cross-examination, to give directions to any individual as to how often or how seldom he should eat during the course of the day. Speaking broadly, we should eat at intervals of from four to six hours. And perhaps, speaking in the same broad manner, and considering the conditions in which we are living, we ought to take food three times daily. That, however, has to be taken, as in the other case, with allowance. There are some people who eat a great many times, and thrive in so doing; there are others who only eat

once in the day, and thrive on that plan. There are some Indians, for instance, who live by hunting, and consequently, their food supply being precarious, they accustom themselves to devour an enormous meal, like the boa-constrictor, at one sitting, and they are able to go without food for two or three days afterwards. It depends greatly on the circumstances in which we are placed, and also on the conditions of life by which we are surrounded. But here is a practical matter that we ought very carefully to note—we can train and accustom the body very fully to definite periods of supply. There is the great law of habit, and also the tendency to periodic action in the body to which I have alluded elsewhere. We may train the stomach to be ready for food at particular times, and to be ready to deal with it at these particular times. It is of consequence, on this account, that we should have fixed hours of eating, especially when our arrangements are such as to prevent times and seasons being absolutely under our own control. We cannot order our ways exactly as we should like, and therefore we have to accommodate ourselves to the necessities under which we are placed. But when we find that we have certain times that are most readily available for purposes of eating, we should train the stomach to some extent—and to a very large extent it can be done—to deal with food at these times. I think that hunger or appetite is the best test. But

we can train our stomach to be hungry at the proper time, so that we can say to it, "Now you set about dealing with the food, that you may be ready for more at two o'clock, or at six o'clock." By this training we may find it calling for food at the time that it is convenient to give it. It is a very important matter that we should be able to arrange things after this fashion, so that, when it is fitting and convenient for us, we should be able to attend to the wants of the body.

As to the *quantity* of food—that is a very large and a very variable word. I believe that most people eat a great deal too much. I believe one of the most fruitful causes of indigestion is just this habit of eating too much. One of the reasons why we eat too much is, that we follow taste rather than appetite. Our food may be prepared in too tempting forms, and we may have too great a variety of dishes set on our table. I remember on one occasion sitting down to dinner in a continental hotel and having at least twenty courses! I do not know how many more I might have had, but when it came to twenty I went away! When we have a great variety of courses we are induced to eat a great deal more than we would be likely to take if our supply had been limited to a single dish. Variety excites and stimulates taste. I am not saying a word against this in certain circumstances. It may be desirable to appetise the individual, that is to say, to bring various foods in tempting

forms. But it is a very bad thing to pamper the taste, and to tempt ourselves to eat more than we should eat, by the palatableness of the viands. It is not a safe nor a wise thing to take them unless we have a normal appetite; or to force, coax, and persuade ourselves to eat when we have no natural relish for food. I believe that relish, or liking for food, is a very fair indication of the digestibility of the food that we take. Unless we have that, the food is not so likely to be made useful in the body as it would otherwise be. But when people have a great variety of foods placed upon the table, they may go on stuffing themselves, with one kind after another, until the stomach is overloaded to an enormous extent. The stomach is elastic; it is not made of india-rubber, though it resembles it somewhat in capability of enlargement; and you can swell it out to a very remarkable extent. Some people do that when they push down one kind of food after another, until they feel a tightness across the region of the stomach that they ought not to feel. Any feeling of this kind indicates that too much has been eaten; there can be no doubt about that. What the old Quaker said is not without force: that one should always rise from dinner with an appetite. At all events we ought to cease eating as soon as the relish is gone. If we take a great many different kinds of food prepared by all kinds of culinary devices, spiced and sauced in such a way that they

make us long to eat them, then we are very likely to err in excess. It is said that the celebrated Mr. Abernethy when visiting his patients, sometimes went into the kitchen to shake hands with the cook, saying, "If it were not for you, and such as you, we physicians would have very little to do." Certainly we may, by overfeeding, overwork the stomach, and we may really starve ourselves by stuffing. The amount of food we take does not determine the nourishment the body gets; that depends on the amount assimilated. Even if it were possible to consume a ton of food, if we can only assimilate one pound, it is only a pound of nourishment that is attainable, and we may defraud ourselves even of a large portion of that quantity by plethoric overtasking. I believe, as I have said, that, with few exceptions, we all eat too much. Remember that if we live sedentary lives we are not competent to perform the gastronomic feats of fox-hunters, or sailors, or ploughmen. We do not need such a large amount of food as they do, and we act foolishly, and must suffer in consequence if we live as freely. I believe a great many cases of indigestion would be very much ameliorated, if not cured, if those who thus suffer were induced greatly to lessen the supply, and also to take especial care in choosing just that kind and amount of food which experience will teach them to be most suitable for satisfying their bodily wants.

Now about the kinds of food. I have been asked several questions about vegetarianism. These questions may be resolved into one: Can we subsist as healthfully on vegetarian diet as we can on a mixed diet of animal and vegetable food? Now, I believe that it is possible for men to exist either on animal substances, as the hunters in the pampas of South America do, or on vegetable substances, as the tribes of Northern and Southern India do, or upon a mixed diet, as most of the inhabitants of Europe do. I think no physiologist would venture to deny, with our present knowledge, that full, vigorous life can be maintained either on the one diet or on the other, or on a combination of both. So that the question is not, whether it is possible for us in certain circumstances to live on one kind of food or another; but rather what, under our actual circumstances, is the best kind of food? It will not do to say, as has been sometimes said, that a simple vegetarian diet is unsuited to cold climates. It is true that the inhabitants of very cold climates, such as the Esquimaux, can get through, I am afraid to say how many pounds of whale blubber, and gallons of train oil, at a single sitting. They can devour large quantities of animal food of different kinds, and seem to thrive fairly in so doing. And in our own country there can be no doubt that many are able to do a very large amount of work by devouring large quantities of animal food.

I shall reserve for the present any expression of opinion as to the difference between diets in connection with muscular exertion. But as to the possibility of being able to live upon a vegetable diet alone, I think there can be no doubt. Large numbers in Ireland and large numbers in the highlands of Scotland, at no very distant day, have lived almost entirely on vegetable food. Some of our boldest, strongest, and bravest soldiers have been drawn from the wilds of Connaught and the highlands of Sutherland, where men were fed mainly, if not altogether, on vegetable food. Therefore it cannot be urged that you may not have men nourished as effectually by a supply from the vegetable world as by a supply from the animal world. Comparing the two kinds of animals represented, by the ox on the one hand and the lion on the other, it has been said that those who live on flesh are more vigorous, and can more quickly put forth their strength than the others. I am not sure of that. The antelope and some other animals are quite as quick as the tiger, or the lion, and certainly for strength or force you find in the draught horse as much vigour and endurance manifested in proportion to size as in any other animal; so that arguments of that kind are out of court, and we are reduced to this question: For me, as an individual, and in my circumstances, whether is it better for me to confine myself simply to a diet derived from the vegetable

world, or to one partly derived from the animal world and partly from the vegetable? And I venture to say that is a question which each one must endeavour to answer for himself. I do not think we can lay down any rule that would apply to all. If any one wishes to make the experiment, I would only say, Do not make it suddenly. All sudden changes are dangerous. We have experience of that in this city (London), where sudden great changes in temperature occurring within an hour or two often prove hurtful. Sudden changes of any kind in the body, even from bad to good, may prove dangerous. And even if it were better to live on a purely vegetable diet, it is not safe to make the change absolutely at one stroke. It is better gradually to accustom the different parts of the body to any change that it may be desirable to make.

For my own part, I can only speak personally, because, as I have said, it is a personal question. After making experiments in all directions—I have been a vegetarian for months together—I find that I can best live and do my work by taking a small quantity of animal food daily. I do not think that I generally take more than four ounces of animal food. You will find in books that we ought to take a much larger amount, but I find personally that that quantity is quite sufficient for the performance of such work as I have to do. I do not lay that down as a rule for others,

I am simply telling you what I find to be most serviceable in my own case. Indeed, I may say frankly that I admire, and sympathise with, the Duke of Wellington's carelessness about niceties of diet. When he entered Paris he was invited to dine with Cambacérès, one of the leading statesmen of the time of Napoleon. This man was a great gourmand, and prepared a very *recherché* dinner for the Duke. He handed him some dish that he expected him to like extremely, and when he had put some of the contents on his plate he expressed a hope that he found it agreeable. "It is very good," said the Duke; "but really I do not care what I eat." "Not care what you eat! What in all the world did you come here for?" was the answer. The Duke did not really care what he ate; he was simply anxious to get through his work. And I believe that is the safest condition in which to live. It is reported that the Duke's cook said, "If I prepare a dinner that Francatelli would envy, he takes it and says nothing. If I go out and leave him to dine on a repast prepared by the kitchen-maid, he takes it and says nothing. That hurts my feelings!" I believe that the right state is one in which we can enjoy any kind of food that maintains the body in health and vigour and enables it to accomplish its purposes. Our appetite should not depend on stimulation and excitement.

II.

EXERTION: MUSCULAR AND MENTAL.

"IN the sweat of thy face thou shalt eat bread." That is a very old sentence, and it has found fulfilment in every century since it was first spoken. We cannot tell what the condition of a perfect physical body may have been previous to the introduction of sin. But for such bodies as we possess, the necessity of labour is beneficent discipline. I do not read in the sentence simply a curse; I read kindness also. God intended that we should be trained by hardship to receive His message of grace and to enter into the fulness of blessing. And we know that throughout all the world, where life is easy, and food is obtained without much exertion, there is idleness with its attendant evils. The two great excitants, or conditions of wrong-doing, associated with each other in the writings of an ancient prophet are "fulness of bread and abundance of idleness." Where you have these two together, the sins of the flesh are very apt to follow in their train. And if we would avoid these sins and enjoy the wealth of life that God designs us

to possess, we must only eat that which is sufficient, and we must work manfully so long as we live. "If any will not work," said Paul, "neither shall he eat." And although he spoke these words with a special and definite purpose, we may adopt his language as strictly and physiologically true. Appetite depends on labour, and if any man does not exert the power that he possesses he will cease to have the appetite necessary for recruiting that power, and "from him will be taken away even that which he hath."

There is an old story that I dare say some of you are familiar with, about an Eastern monarch, who, through having too much to eat and too little to do, fell into a condition of ill-health. The physicians attempted to remove his disease in vain. But a wise and not over-scrupulous dervish went to the king, taking with him a ball and a bat. He told him that some most precious and restorative herbs were skilfully introduced into the handle of the bat, and that if he took the bat in his hand and drove the ball against a wall for two or three hours daily, these precious ingredients would enter into the pores of his hand and flood his body with health. It happened according to the dervish's prophecy. The king continued to follow the instructions from day to day, his wasted energies returned, and he was enabled to resume his duties with pleasure and success.

I need not tell you that the story of the valuable

and costly elements was not exactly true, and that the whole cure depended on the exercise which the king was induced to take. I am afraid that oftentimes we neglect very valuable means for recovering or increasing our strength because they are so simple and so available. We are inclined to think that if some special elements, very difficult of attainment and very costly, could be introduced into our bodies, then we would be able to gain much more vigour and to do our work much more successfully. Depend upon it the simplest means are always the best. The method of regaining and retaining health is not far to seek.

Let us examine, for a little, the basis on which physical exercise depends for its usefulness—for maintaining the health we enjoy, or recovering health when it has been lost. You are aware that the body is continually wasting, and that we have to supply, in the form of food, new materials daily. I want to fix your attention on this fact: in proportion to the *continuance* and *swiftness* of these two processes—waste and supply—depends the amount of physical vigour that we continue to possess. Quick wasting leads to a demand for quick supply, and if there be a sufficient amount of food provided for us, we take it pleasantly and we use it well. The first stage, so to speak, that we have to look at very carefully is this one of waste. We think that if we can stimulate our appetite, then, by the introduction of food into our bodies and the

enjoyment of it that appetite brings, we can have strong and healthy life. But there must be a preliminary waste of substance and removal of substance. There is a certain amount of waste going on whether we will or not. There is an expenditure of energy within the body, and the internal organs waste their substance in doing their work. The heart expends power; the stomach expends power; all the organs in the body expend power. And they require to be supplied continuously with new materials to maintain their energy. And that which they waste must be removed, in order that they may avail themselves of the new supplies. And it is quite possible for us to be so careless about the means for the removal of waste as to leave these organs very much in the condition of a furnace that has got choked up by ashes and *débris* so that it ceases to be available for efficient work. There must be, then, in the case of these inward organs that we possess, a continuous removal of the waste incurred in their working, that we may maintain them in a good and healthful condition.

Then, besides, we must increase expenditure by actual physical labour, to a certain extent, if we would maintain all the different parts of the muscular system in full and useful vigour. The muscles are organs just as much as the eye, or the ear, or the heart, and it is needful that they should be trained for their work,

and that they should be employed in their work regularly, in order that they may be maintained in their proper efficiency. I venture to say that there are many muscles in the body that are neglected, and that if we were wise enough to attend to them all, we would find that not to neglect one would materially increase, not merely the strength of that one formerly neglected, but also the vigour and vitality of the entire organism. If we desire to have fulness of life we must secure fulness of waste. Not only must we supply the body with proper food-material; we must also have that material speedily removed so soon as it has done its work, that it may be replaced by fresh material. It would seem that in the body all the vigour and force depend, somehow, upon the *freshness* of the various tissues that take part in its work, and that as they are deposited in their places they quickly lose their freshness, and with it their power. And it is needful, if we would maintain strength, to have these old materials swept away and new materials put into their place. I do not know that we can fix exactly or accurately the length of time that any of the tissues maintains its fulness of life; but we are quite sure of this, that it is by perpetual change and speedy change that we maintain the largest amount of strength, and are able to enjoy fully the life that God hath given to us. Without attempting to indicate any connection between old materials and gloomy thoughts, I believe that there is

no better cure for a great many of these mental feelings that are so depressing—no better method for getting rid of troubles that are to us sometimes tremendous burdens—than by such vigorous bodily action as will hasten the removal of waste and worn-out particles, whilst it awakens appetite for wholesome food in which we find new stores of freshness and vigour.

The truth I wish to impress upon you is this: that speedy change is essential to fulness of health. We are sometimes told that certain things are exceedingly useful in arresting waste, and they are recommended as valuable adjuncts of diet on that account. I do not think that in ordinary circumstances any of us should be careful to prevent waste. So long as we are able to get and to use new material, the greater the waste and the speedier the waste the better for us. The arresting of waste may be valuable in certain cases of disease, or in certain cases when food cannot be taken, or assimilated, or when food is beyond our reach. But when it is in our power to get abundance of food, and when we are able to appropriate the food supplied, the arresting of waste is the greatest possible folly. The more quickly our substance is spent the better. We cannot be too frequently renewing ourselves, because it is in the possession of the freshest materials that we secure the possibilities of the best and most active life.

Allow me to insist that exercise of different kinds is

not only of special value in forming rightly, and also in developing, the different muscles that we are in the habit of using, but it bears also immediately and closely upon the whole well-being of the body. I hope you understand the importance of that statement. Some are disposed to think that muscular effort is simply intended as training for special muscular exploits. We need not depreciate the value of special arrangements whereby men are prepared for the performance of extraordinary feats. I may have a word to say on that subject by-and-by. But we have to learn this: that it is much more important to all of us—because many are not called upon to perform any of these unusual tasks—that by attending to the full exercise of our muscular functions we are aiding all the different organs of the body in carrying on their work successfully and well. We thus help the lungs to do their work; we help the heart to do its work, and the stomach to do its work. I believe that in a great many instances experience has proved that you can most readily change for the better, improper action, or feeble action on the part of certain inward organs, by muscular exercise than by any method dealing directly with the organ itself. Of course it is not difficult to explain this, at least, in some measure, when we remember that by exerting ourselves in any external action, we increase the demand that the organism makes for the supply of

food, and we also prepare for the reception of that food; and unless the exertion is carried to excess—a danger that we must avoid—we really strengthen the different organs in the body for dealing with the food when it is supplied. I believe there is not a single portion of the frame that does not receive benefit directly or indirectly from muscular exertion wisely directed. I use that word "wisely," because I find that some persons, on apprehending fully for the first time the fact that exertion is required in order to health, are apt to signalise the novelty and force of their conviction by an excessive expenditure of muscular power. They want to be strong all at once. They remind me of the countryman who went to a physician to get a prescription for a malady under which he had suffered for a considerable time. The doctor gave him twenty pills to take at certain intervals, during ten days, assuring him that at the end of the time he would be quite well. The simple man went home, and thinking to make the cure speedier he swallowed all the twenty in one dose! So our friends wish to regain health by one bold stroke, and they attempt feats that none but the practised athlete should undertake. They break down, as might be expected, and immediately they come to the conclusion that exercise has been over-praised, or at all events that it is not an appropriate remedial agency in their case. We ought to learn that we can

only attain any such valuable result gradually; we ought not to expect that health and cure are to be mastered by any sudden and extraordinary outburst of energy. We must be content to begin slowly, and to proceed slowly in correcting the consequences of past blunders, and in preparing ourselves for a happier and more wholesome life. There is reason to fear also that many, when the time of their annual holiday arrives, reason after this fashion: "Now I must, by untiring exercise, make amends for the lack of exertion during my long-protracted sedentary employment." They do themselves immense harm by attempting extraordinary physical effort for which they are wholly unfit; and, in consequence, they return to their usual occupation, not re-invigorated as they had hoped, but weakened in body and depressed in mind. They have to be taught that it is necessary to begin at the beginning, and to "hasten slowly."

Perhaps the proper amount of labour of a muscular kind required by men, speaking generally, is what may be fairly expressed by a walk of nine miles a day. I suppose that some of us walk very nearly nine miles a day, and if we do walk that distance we are expending a very considerable amount of force, even if we walk under the most favourable circumstances. For what does this exertion imply? Of course, if I bring into play any particular muscles I train them to obey my will. And in yielding obedience to my will

they demand a supply of blood; they get this and become nourished and grow stronger, and sometimes larger, within certain limits. We have an often-quoted example of this in the brawny muscles of the blacksmith's arm. They are developed and made larger and stronger by these demands to which they respond. Then, besides, when we expend muscular energy there are certain sympathetic effects immediately produced in the heart and lungs. The heart begins to beat more forcibly; the blood circulates more quickly, passing into the lungs in larger measure. We breathe more deeply, and, if the exertion continues, we begin to breathe more frequently. One difficulty that many experience in attempting to perform an unaccustomed task, demanding large increase of exertion, is breathlessness. This scantiness of breath, or, "want of wind," results from the flooding of the lungs with blood, and their unpreparedness to take in at once the extra amount of air required for its full aëration. In training, there is nothing more important than that the man under discipline should learn to adjust the balance of action between the lungs and the heart. He must acquire the art of so accommodating and arranging the relations between these two organs that there shall be no confusion or hardship in their joint working. An experienced runner will not rush from the starting-post at his highest speed: he begins cautiously, so that the heart and lungs may act synchro-

nously, beating and expanding in steady harmony. This harmonious action being maintained, he is able to increase his efforts until he attains the utmost possible speed with comparative ease and comfort. The success of any effort that is made depends largely upon the wind of the individual who makes it—upon his being able to "stay"—to continue this simultaneousness of action between the main organs while he is doing the work. And I repeat that you cannot have that secured except by a process of gradual adaptation, or, as we term it, "training"—a careful practical adjustment of the action of these two organs.

Now, it is very hard to get men to understand that this must be done slowly, and that by following a well-devised method for days together they are much more likely to acquire this capacity for continued exertion, than by any ill-advised reliance upon natural powers, suddenly stimulated to their highest action. Besides, such stimulation, followed by irregular action, may cause serious injury in the lungs or in the heart. At all events, those who are ordinarily engaged in sedentary pursuits must remember that when they resolve to take sufficient exercise they must content themselves with slow progress, and must not endanger health by rash and violent excesses.

What kinds of exercise are best adapted to physical well-being and development? In answering this question we have not merely to consider what is best

in any circumstances, but rather to consider what is best in the particular circumstances in which we are placed.

When we were boys most of us took enough exercise without thinking about the matter at all. Children take exercise when they are allowed to move freely. And permit me here to say that the children of the poor, in being allowed to roll and crawl on the floor, have a great advantage over those miserable over-cared-for children that are always swathed and carried as if they were pieces of precious porcelain. We were accustomed in our younger days to engage in what we called "play," and in what some people perhaps would have denounced as frivolity and waste of time. Physically speaking, there never was time better spent than the time spent in play. And if we could reserve the right and enjoy the privilege of engaging in such sports as commanded our energies when boys, we would find it an immense advantage to us our whole life long. I do not know that there are any better exercises in which all the different parts of the body may be developed and the health of the body invigorated and secured, than those ordinary games, with all their charming diversity, in which we engaged so heartily when boys at school. I have not a word to say against gymnasia, if they are good and well appointed. There are great advantages to be gained in connection with them, and

under skilful management they form a very valuable adjunct to the methods we may adopt for increasing the strength of the body, and they may be almost the only means available to us dwellers in cities for gaining this desirable end. But if it were within our power to retain the sports of boyhood, nothing would be preferable to these. For my own part, I enjoy nothing more than to find myself in the company of merry young people, and to become a boy again, in buoyancy if not in bulk. I am sure of this, that nothing does me more good, physically, than to play at these childish games of which some people are foolish enough to be ashamed. Only silly or sensuous minds will condemn the games of childhood. The recreations of grown-up people are not always so innocent, and rarely so physically wholesome, as the joyous sports of boys and girls. In these sports the muscles and the mind are both brought into play, naturally and vigorously. If we could retain a great many of the customs of our boyhood, and retain them to the exclusion of a few of the customs of our manhood, it would be better for us all.

There is, however, another fact in connection with the expenditure of force that demands special attention. We find, as I have already hinted, that when we begin to exercise our muscular mechanism, the breathing process is accelerated. Suppose we assume the quantity of air breathed when we are lying down,

or, as some would say, when we are in the recumbent position, as the *unit* from which we calculate, we find that if we walk at the rate of four miles an hour, the quantity of air breathed is increased fivefold. In a state of quietude we take in 480 cubic inches of air per minute; but when we walk at the rate of four miles an hour we take in five times that amount, or 2,400 cubic inches of air per minute. If we walk six miles an hour, the walk then passes almost into a run, we take in at the rate of 3,260 inches per minute. When you remember the work that oxygen does in removing waste materials from the body, and when you remember that oxygen proves itself to be a most invigorating element, you are prepared to estimate the important action upon the whole well-being of the body which may result from a brisk walk in a clear atmosphere. On the other hand, if we exert ourselves even violently, in a crowded room, or in a small or badly-ventilated room, we do not breathe healthful air, but air loaded with the poisonous products of respiration; and in that case we lose instead of gaining, we are storing up harm rather than health. This is an important consideration, in connection, for instance, with such exercise as dancing. I have not a word to say here about the social and moral relations of this recreation. But as it is practised in cities in crowded rooms after nightfall, in which the air is vitiated by a great many gas-jets, as well as by the

hurried respiration of a numerous assembly; it fatigues rather than recreates the body. It sends home those who engage in it to a feverish and restless couch, to rise up unrefreshed and weary next morning. It does not give to us that calm, refreshing sleep which genuine exercise in the open air would give, and it does not enable us to return to our duties next morning with the vigour that would result from such exercise. And even if we take well-regulated exercise in a gymnasium, unless it be a lofty and well-ventilated one, the results are not at all such as we could desire.

For, after all, the important thing is to secure, by means of this increased action of muscle and lungs, that there shall be active waste, and that the waste substances shall be freely removed. Oxygen is the true *eau de vie*—the water of life, or rather the air of life. Nothing exhilarates like oxygen. Nothing refreshes and recreates both body and mind, speaking physically, like oxygen. If we want to have every cloud that envelops and depresses us removed, let us breathe volumes of pure air: we will find that this nimble invisible agency will soon abstract from us our megrims and melancholies. For, while I do not underestimate the value of exercise in invigorating or strengthening particular muscles, and so enabling us to endure fatigue or accomplish certain tasks, I place this fact in the foreground, as of the greatest value, that it enables us to breathe fully and freely the vital

air. Consequently, I insist again that the taking of exercise in crowded rooms, and in places in which we are not able to breathe a pure atmosphere, is not at all advantageous to any considerable extent.

I can scarcely insist too strongly on the value of wholesome exercise, believing, as I do, that a great many of our feelings of a moral and social kind are dependent on the healthfulness of the bodily frame. May I venture to say further that a great many sins become easier, and the temptations to them become stronger, when we do not keep the body in a normal condition. I do not know many conditions more exposed to temptation, and, therefore, more entitled to practical sympathy and help, than that of young men who have an unlimited supply of nutritious foods, and who are so circumstanced that indolence and inactivity are fast growing into habits; and for them one great preventive of evil, and a very valuable one, which I would honestly and earnestly prescribe, is HARD WORK, even to the extent of great bodily fatigue. If that prescription be followed, it will nullify to a remarkable degree the inclination to do wrong. Besides, as I have said already, it will keep the body strong. Mr. Abernethy is said to have given this as one of his most valuable recipes: "Live on sixpence a day, and earn it." And there is a story told, I am not sure of its truth, but I am sure of its reasonableness, of some one who called on a

learned physcian to consult him about his sufferings from over-repletion, and was told that all he had to do was to steal an umbrella as he went through the lobby. He (the physician) would then give him in charge to the policeman, and if he were fortunate enough to be sentenced to one or two months at the treadmill he promised him that he would be thoroughly cured!

I do not think it needful to give details regarding the foods that are specially adapted to physical development, because you will find full information on that subject in any of the books that discuss the process of "training." However, I ought to say this, and I think I gave indications of my belief in the last lecture, that foods containing fat and oil for those who have to perform vigorous work are of very great value, and that nitrogenous foods to those who have to do special work are also of specific importance. There was a very instructive illustration of the value of certain diet given in the re-laying of the rails of the Great Western Railway between Grange Court Station (near Gloucester) and Milford Haven, in the year 1872. Gangs of men were employed to do the work, and very hard work it was; they had to work from seventeen to eighteen hours a day for several successive days. Of course the operation of narrowing the gauge on a railway was a task that could not be delayed. The men had to lift up the heavy

rails, and lay them down in another position, and they had to do it very speedily. The men had provided themselves with two weeks' provisions of cocoa, coffee sugar, bacon, bread, and cheese.

The following extract from a letter written by J. Ward Armstrong, Esq., Divisional Engineer, explains fully the plan adopted for their refreshment: "At early dawn water was heated at the lodges and breakfast made. That over, a start was made for the scene of the day's work. Two men went in advance provided with a large iron pot, and oatmeal in 28lb. packages. Water being found, a fireplace of stones was soon made and the pot boiled. Oatmeal was then sprinkled into it and added until thin gruel was made. As soon as the shout for drink was heard, buckets were filled and carried round, small tins being used to drink it from. The men soon got to like it exceedingly, and used it very largely to supplement their solid food. It was the only drink taken during the day. I had not a single case of drunkenness nor of illness. I have often since heard these men speak with great approbation of the supporting power of oatmeal drink." [1]

It will be noticed that the oatmeal was cooked. I

[1] There is an amusing reply said to have been given by a Scotchman to an Englishman who sarcastically reminded him that "oats were food for horses in England, and food for men in Scotland." "So it is," he said; "and where else will you find such horses and such men?"

think it would not have answered nearly so well if it had not been. At the same time it has long been common for men labouring at the furnaces in large iron works to drink cold water and oatmeal.

I judge it right in this connection to say that *alcohol does not give strength.* And in making that statement I think I am making a statement in which medical men who have studied the subject will agree with me. Whatever be its uses—and we are not considering them just now—it certainly does not impart vigour. Sir Garnet Wolseley proved, in the hard work done by the men in the Red River expedition, that withdrawal of alcohol was not a withdrawal or lessening of force. From his account of the expedition, and also from the narrative of others, we learn that never were men better behaved, and more healthy in performing such a task, and never did they go through the fatigue of such an arduous march with less evil consequences. During the Ashantee expedition we find that, although a certain amount of rum was served out to the men, they speedily discovered that it was not advantageous to drink it during the day's march. A very small quantity was allowed, but even this they found on trial was not conducive to their comfort during the time of active exertion, and they preferred to take it at the end of the day, when they had encamped for the night. Of course then they had the opportunity of sleeping it off, and it would do

them the least harm, under the circumstances.[1] Dr. Parkes made certain experiments on three soldiers, intelligent men, who lent themselves willingly for the determination of the facts which he desired to ascertain. He arranged that they should march 20½ miles daily, at the rate of 3.2 miles per hour for six *successive days*. They were equipped in heavy marching order, carrying, with their clothes, about 51 lbs. weight. The march was divided into three parts of 13¼, 4¼, and 3 miles, and they were all alike allowed the usual rations daily. But in addition to the food he supplied the men with rum to the extent of 5 oz. daily on two of the days, with coffee to the extent of 1 oz. two days, and with Liebig's extract of meat to the extent of 1 oz. the other two days. In each case these rations were divided into two parts. He gave 2½ oz. of rum before the second and third sections of the march; the coffee and the meat extract were administered in like manner. These rations were served, not on successive but on alternate days, in order to make the experiment more complete. He asked the men to state honestly their own feelings, and to tell, in writing, which of these three kinds of rations they thought most helpful, and which they thought the least helpful. They were unanimous in giving the meat extract

[1] See a full and interesting account of this experience in Dr. Parkes' book, *On the Issue of a Spirit Ration during the Ashantee Campaign of* 1874. J. and A. Churchill, 1875.

the first place, and in giving the alcohol the last place.[1]

Dr. Richardson has made a curious experiment on the muscles of a frog's foot, ascertaining carefully how much it could lift, and he found that its lifting power was sensibly decreased by the administration of alcohol.[2] Indeed, it has been accepted by almost all who have had experience of hard work, that when any special task is to be done, or any special fatigue to be endured, alcohol had better be avoided. I want to guard you against the idea that it gives strength, or increases our power for doing useful work. I do not say anything about its hurtful effects in other directions. One of the greatest advantages of muscular training is that we learn how to proportion the amount of strength needed to accomplish a given result. An individual attempts to do something he is not accustomed to do, and spends a great deal more strength than is necessary; but by-and-by, when he is trained, he does the same thing more easily and with far less expenditure of strength than before. If we imbibe alcohol we lose this power of proportioning the expenditure to the work to be done, and it is found that those who work under alcohol are more fatigued and worn out by their exertions, because they have

[1] A full account of these experiments is given in the work already cited, Dr. Parkes *On the Issue of a Spirit Ration*, &c. Appendix i. p. 39.

[2] Richardson's *Cantor Lectures on Alcohol*, p. 73.

wasted more force than those who have not been under its influence. There was a very celebrated gang of navvies on the Great Northern Railway that accomplished more work daily than any other gang, leaving off work an hour or an hour and a half earlier than any other men, and every man in the gang was a teetotaler. Mr. Brassey gives this fact in his interesting book on *Work and Wages* (p. 17, Ed. 1874).

I fear I have left little time to speak about mental exertion. I do not intend to say anything about the action of the brain. I wish to speak simply of the exercise of the mind. And very much the same laws that govern the exercise of the body govern the exercise of the mind. Just as the body becomes more fit for doing its work by careful exercise, so does the mind. According to the statistics of the Registrar General, the longest-lived people are barristers, who have to do a very large amount of brain-work; and the shortest-lived people, according to the same returns, are innkeepers, who have to do a very small amount of labour.[1] I do not mean to say that the innkeepers, by not exercising their brains, shorten their lives, because we have no difficulty in finding other reasons for the high rate of mortality among them. But the exercise of the mind is healthful, if it does not lead us to neglect the wants of the body.

[1] Richardson's *Health and Life*, p. 212. Daldy, Isbister, and Co., 1878.

Indeed, I believe that to keep the mind fully employed wonderfully strengthens and invigorates the whole life. Only mental exercise must be properly regulated. Expecting the mind to do what it has not been prepared to do, and bringing it to face great difficulties for which it has not the preliminary training, may debilitate and injure it: just as setting the muscles to accomplish a feat for which they are not competent may weaken instead of strengthening them. Our minds require to be trained no less than our bodies, and if they are trained they will increase in power amazingly. You will find, for instance, that many books that you thought very dry reading on first handling them, after a year, when you have become more familiar with the subjects they discuss, become very easy and very pleasant reading. I have sometimes found, and I expect I shall find it again, when I took up an elaborate treatise on some intricate subject, that I could make nothing of it without very careful and very concentrated thought. In these circumstances it is generally better to put it aside and to begin with some simpler book, in the perusal of which we may become gradually familiarised with the subject. Then if we take up our old friend we shall find him very pleasant company indeed. One great object of training at school is to develop and determine the mind for higher, and still higher, exploits. A great many of the tasks which are given

us in early life are of immense value as mental gymnastics. We are inclined to ask, Is there not a great deal of time wasted in acquiring useless knowledge? No time is wasted that strengthens the mind for gaining knowledge afterwards.

I wish to add this—because it bears upon the training both of mind and body—that pleasantness has a great deal to do, not merely with the comfort that we find in such training, but with the success that attends it.. I have a very strong belief—as you may have observed more than once in these lectures—in the goodness of God. I find traces of it everywhere, and nowhere more than in this: that good things are made pleasant things, and desirable things are made enjoyable things. I do not know that there is a more suggestive word in the whole Bible than that spoken by the Lord Jesus: if we ask good things from God, He will give them to us. "If ye, being evil, know how to give good things to your children, how much more will your heavenly Father give good things to them that ask Him?" I believe that God never refuses us good things; but the difficulty is to get us to desire and to ask good things, and to be willing to take them. We are very willing to have stones and serpents, but very unwilling to take bread. God has associated goodness and pleasantness, but we are slow in discovering the connection. And the best way to get benefit in exercise, whether it be of body or

of mind, is to find enjoyment in the exercise. It was so when we were boys. We did not look upon our play as task-work. If anybody had said it was to make our muscles strong, and to develop a vigorous organism, we would have replied, "We do not trouble about that; all we care about is the enjoyment." So with study. Let us take up something that interests us. Depend upon it, we can make no progress in training unless we are interested in it. It is of little use to take our "constitutional" because we think we ought to do so. We must put our heart into it. It is only as we are able to throw our whole soul into anything that we pluck forth that benefit from it which it carries in its bosom.

Attention is the basis of memory, we are told, and so it is. Without attending to any matter you cannot remember it. The secret of a good memory is attention, and *the secret of attention is interest.* Consequently the first thing we have to do is to learn to take interest in what is good for us, to learn to appreciate the goodness of it. There is nothing grows more rapidly than our sense of the goodness of a thing. There are some people in such an unhealthy condition that they cannot attend with interest to any matter except their own miserable complaints, and you have to force them to begin. As soon as they get the blood rapidly coursing through their veins, they are stimulated to continue, and then it may prove almost

equally difficult to get them to leave off. Enjoyment is the best stimulus to perseverance. So with learning. Let us first get interested in some study. This is the reason why we give boys amusing books, that at the same time contain something instructive. Unless you get hold of their minds you cannot convey instruction to them. If we get interested in the subject of study, then we shall find that the very pleasantness of it will carry us onward, the mind will be at once storing up information and developing its faculties for other efforts as we proceed.

III.

WORRY: PRODUCTION AND PREVENTION.

MANY centuries ago a Roman poet noted the value of "a sound mind in a sound body."[1] Increase of knowledge and experience enables us to attach very full significance to his words. It would be difficult, indeed, to exaggerate the importance of these two things in intimate union—a sound mind and a vigorous body. I am not disposed to argue that it is impossible to find soundness of mind associated with weakness or disease of body. There have been instances of men, great in various departments of life, who have accomplished wonderful works notwithstanding the frailty of their animal frame. Nor am I disposed, on the other hand, to argue that it is impossible to find soundness of body without soundness of mind. It would not be difficult to find very excellent specimens of human animals who have no intelligence worth noting, and who are not distinguished by any of those qualities that elevate men above the brute creation. But we are all agreed that

[1] "Mens sana in corpore sano."—*Horace.*

where we can get these two things united—clearness of mental vision and ripeness of mental judgment, along with strength and healthfulness of body—we have got a very remarkable and a very valuable combination. The attention of Christians has been called in modern times very often, and I think also very fairly, to the importance of physical cultivation and development. This culture has been jocularly called "muscular Christianity." I really have no objection to that or any other phrase that may be applied to it; but the duty itself, of taking care that our bodies are in strong and vigorous health, is one which I am not inclined to think it possible to exaggerate. In such a world as this it is important that our circumstances be as favourable to right living as possible, and those who are acquainted with the influence that an unsound body has upon the mind and upon the heart, and consequently upon the character and life, must know that it is important to prevent or remove that unsoundness by all the means at our disposal. We need Divine grace, but we are not to despise human helps and appliances. And whatever makes it simpler, whatever makes it less difficult, to avoid sins of any sort, is earnestly to be sought and carefully to be retained.

Sometimes it is argued that Christians are inclined to lessen the significance of the body's action upon the mind, and to neglect or overlook this close,

influential connection between the physical organism, and thought, emotion, and will. Now I venture to say that the early Christians at least, had what I would call an exaggerated, no less than a mistaken, idea of the influence that the body exercises upon the mind. They consequently attempted to crush the body, and to get rid of its influence by all kinds of foolish destructive methods, so that they might be able to maintain their spiritual action unimpeded and strong. They made themselves emaciated and feeble by continual fastings, by denying themselves the ordinary nourishment which the body craved, by subjecting themselves to hardships strangely devised, in order that they might get rid of the terribly obtrusive and overwhelming action which they believed that the flesh was likely to exercise upon the spirit. I am not inclined to say that they were wrong in endeavouring to gain the victory over this material influence which they found so closely associated with their own sinful dispositions. But I am bold to say that they took an entirely wrong and barbarous method. If we would make the flesh claimant, if we would prove its power to obstruct and injure us in every possible way, we cannot take a better method than by starving, ill-using, or neglecting it. And the weird visions of various kinds which these good men had, and many of their grim and grotesque conflicts with the devil, arose simply from the fact that the body was revenging

itself upon them for their strange and stupid treatment of it.

Our method in these days is different. We wish to have the body in such a condition that it will not obtrude itself upon our attention at all, and we endeavour to secure this non-interference by maintaining it in vigorous health. We are hardly conscious of the existence of any of the organs of the body when they are working freely and fairly, and if we could so arrange it that all the parts of our physical frame continued to perform their functions without any harassment or obstruction, we would find that the body would at least present no hindrance either to our thinking, or feeling, or willing. This close connection which we admit between the body and the soul, or between the body and the mind, has never, I think, been overlooked or forgotten (however mistaken may have been their practice) by Christian men.

I venture to say, on the other side, that there has been a considerable amount of misapprehension—I am not inclined to say misrepresentation—on the part of those who have not been disposed to give full value and significance to the facts that determine the action of the mind upon the body. I admit freely—no one can admit more freely than I do—that the body does influence the mind in a hundred directions and to a hundred different issues. But I maintain just as strenuously, on the other hand, that the mind

influences the body, and that it can tell upon all the actions of the frame, and upon the performance of the body's functions, in a very strange and startling manner. Who does not know that imagination can kill and imagination can cure? Who does not know that by a morbid attention to particular parts of our body we may even originate disease in these distinct parts? It was discovered many years ago that certain operations or movements, conducted by means of certain instruments called "metallic tractors," curiously prepared, exercised an extraordinary influence on certain parts of the body, and that apparently by means of these movements many diseases could be arrested and cured. Two sceptical and sagacious physicians in Bristol, having their attention directed to the subject, found that they were able to cure the same kind of diseases as effectually by means of wooden imitations of these tractors, in which not one particle of the supposed metallic virtue could possibly reside. Perkins's metal tractors were consequently banished from their high place in the list of remedies. But whence had they the power which undoubtedly they exercised? I do not think that medical men have given sufficient attention to this subject, so far as it bears on medical practice. These tractors excited confident expectation of cure, and therefore cures followed their use. And I believe a great deal might be done by exciting hopefulness, and

the expectation of recovery, and even sometimes by awakening an earnest desire for recovery, in the minds of patients. Those who are acquainted with the influence of hope, and I may add the influence of despair, upon armies in the field, know how effective for good or evil these passions may become. A beaten army always gives the surgeons a great deal more trouble, and its diseases assume a most unfavourable type; while a victorious army, although it may have a large number of wounded and diseased, is always more easily treated, and its diseases and wounds are more readily and effectually healed. The influence of the mind on the body is just as real and as constant as the influence of the body on the mind. Let these two series of facts be distinctly understood, and full effect given to the lessons they teach.

In speaking to you on this occasion about "Worry: its production and prevention," I have to deal partly with the one series of facts and partly with the other. I have to recognise, in the first place, that worry may *be produced* by the state of the body; and I have to recognise, in the second place, that worry may itself *produce* a diseased and unwholesome condition of the body. In speaking about the action of the body in the production of this—malady shall we call it?—unpleasant condition at all events, I must grant that a great many people are so constituted that they are much more easily worried than others—in fact, they

ive in a condition of continuous worry. There are lifferent temperaments—the old division, into the anguine, the lymphatic, the bilious, and the nervous, will serve our purpose—and the nervous temperament s supposed to make people more liable to these excitements that are productive of this condition that we express by the word worry.

There are inherited predispositions and qualities that have a very great effect in determining the character of a man throughout his whole life. I am not speaking of those marked cases in which particular tendencies to disease are manifested in due time by the production of definite disease. Nor am I making reference to insane conditions, or nervous conditions which approach indefinitely near insanity, and are transmitted from one generation to another. But there are slight peculiarities, slight in themselves, but somewhat annoying in their results, that are handed lown from father to son, and make themselves felt hroughout a long-continued life. Can anything be lone to meet such an unfortunate condition? I enture to say that a good deal can be done. We are ble, at all events, to bring our bodies into the best ircumstances possible for the exercise of their unctions and the discharge of our duties wholeomely and well. We can at least avoid everything hat would weaken or make them worse than they are, nd we can use such appliances as are likely to

increase their vigour and make them more healthy. Then, over and above that, there is the power that God has entrusted to us as thinking men—the power of controlling to a very large extent—no one can say how largely—all our feelings and anxieties of different kinds, so that we may breathe a calmer atmosphere and live a purer and better life.

There are cases in which there may be so much morbid weakness—abnormal weakness—as to divest the individuals in whom it is found of responsibility. These are cases for the physician and the asylum, and when such people commit crimes they are to be dealt with tenderly and cautiously by justice. But in the ordinary run of cases, where men have strong tendencies and impulses that lead them in directions in which they should not go, the law strenuously contends that they have it in their power to control these tendencies and resist these impulses. It demands that they exercise this power, and it will punish them if they fatuously yield to these tendencies. And I hold that the law is right; because the very fact that punishment is at hand has been found, in a thousand instances, to arrest them when they were bent upon the execution of their own wild impulse and will. There was a case of this kind tried in our country not many years ago, in which it was pleaded in the medical evidence that the defendant was altogether irresponsible, because the impulse to do wrong was so violent

that it became irresistible. The question was put by the judge to one of the doctors in the witness-box, I think fairly, "Do you mean to tell us that if a man had stood beside him with a loaded pistol, and had told him he would shoot him at once if he transgressed the law, he would then have done it?" The medical man was obliged to confess that he would not.[1] Now it seems to me that the admission of that fact implied that there was the power of control, and that these impulses were not irresistible. And where they are not irresistible, we are responsible if we yield to them and allow them to control us, so that we do what we know ought not to be done. I admit freely that people may go on yielding to impulses during many years until these become excessively strong, or rather they themselves become lamentably weak, so that it becomes almost impossible to resist. But I recognise the responsibility of so yielding in the formation of any habit; and it would be a very dangerous thing indeed if, because a man, by long-continued folly or moral weakness, makes himself incapable of controlling his actions, we should set him free from his responsibility and dismiss him from judgment. We have it in our power—let me say this emphatically—to control our feelings and desires to a very large extent indeed. And if we give them free play and scope, and they lead us astray, we cannot claim

[1] Wharton's *Philosophy of Criminal Law*, chap. iii. par. 46.

indulgence. I leave the judgment of the case, so far as the future is concerned, entirely out of sight for the present. God will deal with us according to truth and justice, and there is a suggestive significance in the words of the Lord Jesus Christ: "Woe unto thee, Chorazin! Woe unto thee, Bethsaida! For if the mighty works which were done in you had been done in Tyre and Sidon, they would have repented long ago in sackcloth and ashes. It shall be more tolerable for Tyre and Sidon at the day of judgment than for you" (Matt. xi. 21, 22). God judges us according to all the circumstances of the case, I doubt not. But so far as we ourselves are concerned, if we voluntarily surrender our minds and hearts to evil influences, and allow these to become more vigorous day by day, until we are unable to control them, we must not "lay the flattering unction to our souls" that we can free ourselves from responsibility by such a course of action. It is a very dangerous thing for us to judge ourselves after that fashion, and to imagine that the strength of the impulse is to be pleaded in extenuation of the crime or in bar of judgment. There are no conditions—speaking of ordinary cases—in which the body is fretful or irritable because of nervous weakness in which this responsibility does not exist, and corresponding to which there is not a certain power of control possessed by each one.

There are some people so cross-grained and ill-

natured that it is very hard to get on in this world with them. I have read of one meeting another and politely saying to him, "It is a fine day." He immediately replied, "Who is finding fault with the day? You would fight with a stone wall." I have read of another, who excused himself when he fell into a passion by saying to his servant, who had given him notice to leave because he could not bear his passions, "Well, well, John, you need not take it so much to heart. You know that, although I am passionate, my passion is no sooner on than it is off." "Ay," said the man, "but it is no sooner off than it is on again." There are some people who have this crusty, cantankerous disposition, and when we are brought into contact with them it may be somewhat difficult for us to know what to do. A great many of our worries are caused by others, and are caused by others because of this constitutional infirmity. Permit me to make two remarks on these cases. 1. If we suffer from the ill-nature of others, let us remember that we should make allowance for their weakness. We ought to pity them because of this inherited faculty and facility of doing wrong. If we are wise, we will thank God very earnestly that our temper is of a different sort. And because we have a temper of a different sort we will bear very patiently with them, and our calmness of demeanour will not only fend off evil results from ourselves, but will tend

somewhat to calm even their unmeaning anger. But then, secondly, if we ourselves should have this unfortunate temperament, and find that we are very irritable, and ready to take offence, we are not in that case to pity ourselves, and think that this unfortunate disposition that we are cursed with, and that perhaps we have been born with, must be endured as best we may. We must recognise this truth, that we have it in our power to resist this irritableness to a very large extent, and, indeed, to overcome it. And it is our duty to make the effort steadily and persistently until we have gained a large measure of success. We know this, that when we are in circumstances where we are likely to injure ourselves by our passion or irritation, we are rather careful to control that passion. And I have heard it said that some married men are a little disposed to allow their ill-nature free vent in their own homes, knowing that they are safe in so doing, because their wives will patiently bear with them and make all sorts of allowances in their behalf. But they are rather careful to put a rein upon their inclinations when they go abroad, because they know that they are then face to face with people who will not make the same allowances. It is a very foolish and hurtful thing to allow these influences to exert this masterful power over us at any time, because we are increasing their strength, and making it more likely that they will dominate us in future;

best way to overcome them is to resist them in the simplest and easiest form, to cultivate a kind and even temper when there is the least occasion for that unholy temper to manifest itself. We will thus learn to bring it under complete control, and at length be able to govern it at all times.

A great deal can be done, as I have hinted, in bringing the body into a right condition, so that it may not cause, by its action on the mind, this irritableness of temper. And I may add that a very great deal of what we commonly call ill-humour, springs from the ill-conditioned state of the body. We familiarly talk about people "rising from bed on the wrong side," and there is a very suggestive meaning in the phrase. They may have been sleeping all night in a very badly-ventilated room, or have gone to bed after taking a heavy and indigestible supper. The consequence is, that in the morning, from want of pure oxygen, or from overloading the stomach, the whole organism is out of order, the nerves are on edge, and they rise fretful and impatient, and continue so throughout the day. I do not think it is at all a trivial matter that we should put ourselves into such a condition as that, nor is it unimportant that we should obviate such a state of things by taking great care that we breathe good pure air during the night, and that we do not lie down to sleep in such a condition that we are sure to have unrefreshing slumber,

and to wake exhausted and ready to take offence in the morning. I hold that we are morally guilty in having permitted this state of things to originate when it was in our power to prevent it. And it is really a part of our duty to our fellow-men, and part of our duty to God, to whom we are responsible for all our actions, to take care that we do not throw the body out of gearing by such foolish conduct, and allow it so injuriously to react upon the mind. Anything that weakens the body, that makes it less able to perform its functions, has a tendency to produce this state of mind in which trifles become exaggerated, in which the slightest care or grief worries the mind throughout the whole day. And I hold that this clearly indicates the duty of maintaining good health. I say *duty*, and I take it that this vindicates to the fullest extent what has been called "muscular Christianity." Whatever makes our physical frame stronger and healthier will enable us to act more Christianly, and maintain a better deportment and demeanour in life. And it is of very great importance, especially to those who wish to commend the gospel of Christ to others, that we cultivate such nobleness and gentleness of character as will best illustrate His glorious gospel.

There are many things that irritate our minds and affect injuriously our tempers. Overwork and distressing anxious care, for instance, when we are oppressed by a great deal more than we are able to accomplish;

when we find that there are critical decisions to be made, and we have not the materials present to enable us to come to a safe judgment; when there are harassments and cares pressing upon us from every side that we feel ourselves altogether unable to meet and contend with—the mind naturally gets distracted, and we feel distressed and perplexed. We are liable to such conditions throughout our life, all the more on account of the numerous inter-relations in which we are placed, and they have a tendency to produce this condition that we call worry. It has been questioned whether or not there is more insanity among civilised nations than exists among uncivilised, whether there is more insanity now that we have developed all the arts and sciences very fully, than there was many hundred years ago, when these departments of work and knowledge were not so extensively entered upon. I am not sure that we are able to give any distinct answer to the question when it is put in that form. We are able now to diagnose insanity, and we have measures of dealing with it that make it much more pronounced and recognisable than it is in many of the uncivilised communities at the present day, or than it has been in any of the non-advanced communities of former times, the history of which is accessible, so that we cannot form a fair comparison between the several cases. There is however a very interesting fact noted by Humboldt in the course of his travels in South

America. He met with a tribe, the faces of which were so smooth and unplowed by wrinkles or furrows that he could not tell father from son. They all looked equally youthful. In that case there must have been a very large amount of freedom from care. What tells on most of us in graving these lines upon our face is just this anxiety or worry. I think that the exercise of the mind even to the fullest extent, unless it is carried to a very excessive extent indeed, is rather wholesome than otherwise. And in cases where those who are engaged in intellectual pursuits, or pursuits of business, have the lines deeply traced on the countenance and their lives shortened by the pressure of worry and care, the explanation is to be found in the fact that they have allowed these thoughts and purposes to weigh upon them beyond the necessities of the case. It is worry rather than work that has produced the unhealthy condition. I am sure at all events that if work kills one, worry kills a hundred. We are tempted, naturally enough, either when we look back on the past and survey our errors, to grieve and groan over them unnecessarily; or when we look forward to the future and are dependent upon wise plans for meeting coming evils, we are inclined in that case, especially if we are not able to see light, to be worried and troubled excessively. But when we think of it, we cannot change the past, nor can we by carefulness very much affect the future.

The wisest One that ever lived on earth has warned us against taking anxious thought for the morrow. We cannot, by taking thought, add a single inch to our stature. We cannot change circumstances by any amount of troublesome burden-bearing. If we fully, and fairly, and conscientiously make all the provision within our power for a wise issue in coming days, we ought to be content to leave the matter in the hands of God, and to receive such results as in His providence may be brought about. Depend upon it, we cannot change either the past or the future by taking *anxious* thought. We can do a great deal by taking *right* thought, and I am not saying a word against that. By all means let us think of the past, that we may find out what we have done amiss and guard against wrong-doing in the future. There is a godly repentance that worketh a right state of mind and a right character in coming time. Nor am I saying a word against taking wise thought—forethought, if you will—in regard to matters that are about to happen, which we have the power to influence by our conduct, in this direction or in that. But to trouble and burden ourselves about matters connected either with the past or the future, that we cannot alter, or change, or improve in the slightest possible degree, is to lay upon ourselves an unnecessary weight, and to indulge in worry that will affect us for evil in the present as well as in the future. For this conduct tells upon the body

itself. It does not merely trace its lines on the face, but it makes its impression on the nervous system, and I believe as deeply on many other parts of the organism. It has been commonly said that the liver, when it is diseased, induces men to take a gloomy view of things. I do not dispute it; but I hold, on the other hand, that this worrying ourselves about things we cannot alter, things concerning which we have no power whatever, does injuriously affect the liver and other organs, and unfit them for doing healthfully their own peculiar work. Why, there is a case on record in which a mother has been greatly frightened while giving drink to her babe, and in a few moments the child has been killed as effectually as if it had taken poison. There was such an alteration of the nutriment in the mother's breast that, instead of being a wholesome liquid, it had become a poisonous liquid. That is simply an extreme instance of the effect that anger, fear, and other passions may have upon the action of the internal organs, altering their action very materially, and, indeed, producing a diseased condition throughout the whole frame. The truth is, these two act and react the one on the other. A diseased body produces worry, and worry produces a diseased body, and we intensify the evil exceedingly when we give place to uneasy and anxious feelings in any degree.

In regard to overtasking and those other similar in-

fluences that we have to contend against, this very simple remedy suggests itself to me. It may be said that I am speaking without much experience. A few ladies discussing this subject the other night said, "What do the men know about worry?" So some of you may be inclined to ask, What do I know about it? Well, I suppose I have my cares and troubles as other people have. I do not say it in any boasting spirit, but I have learned in some measure to take things easy; and I do not believe there are many more valuable acquisitions attainable in this life.[1] It requires study and care just as much as the attainment of any other valuable quality requires, but it is worth a very great deal when we have managed to secure it. To be able calmly to look at misfortunes without being disturbed or depressed, and to set about rectifying them as soon as we can, is of immense consequence. If we allow ourselves to be worried and overburdened with care, we are inclined to sit down and say, "Well, I can't do anything; I can't deal with this matter at all." But if we do not allow our minds to be so affected, and if we set about doing what we can, it is astonishing how speedily a large amount of work that we may find ourselves burdened with disappears. We will have plenty of time for worrying after we have finished the work.

[1] The state of mind which I am commending finds its best illustration and defence in the words of the apostle Paul, "I have learned, in whatsoever state I am, therewith to be content."

I am reminded of what one gardener said to another, after the crops of both had been destroyed by a storm. One came and said, "What a pitiful thing it is. I have lost all these excellent crops on which I depended very largely. But *you* are not grieving over it; how is that?" "Oh," said the other, "I at once set about planting another crop. When I have finished so doing, I can take time to grieve over it." "Then there will be no need for you to grieve," was the answer. It was a very good lesson. It is for us to retrieve misfortune or correct error; then, if we please, let us take time for finding fault with ourselves, or with our circumstances, or anything else. If we would just set about doing the work that seems to press on us so heavily, we would find that a very large amount of it would soon disappear. And supposing we did not accomplish all we might have wished to do, we would have the satisfaction of knowing that we have done what we could. And there is no higher praise in the gospel given to anybody than was given to the poor woman of whom Jesus said, "She hath done what she could." Only we must put all our strength into our work. I am not at all endeavouring to instil into your minds the idea that we should wait until something turns up; that we should keep our minds in such a calm and equable state that we take no trouble in the discharge of our duty. I do not want you to imitate Mr. Micawber. We ought to put strength

and vigour into everything we do, and we ought to avoid everything that would enervate, or weaken, or disturb the regular action of our mind and body, or produce in us a condition of indolence and ill health. And I believe that a great many make themselves really weak and infirm by allowing worries of this sort to prey upon their minds, and, through their minds, upon their bodies.

May I note another simple counsel of vital moment? We can accomplish much by the observance of careful method. Allow me to use an illustration from my own experience. I have sometimes to deal with a great many books, and in dealing with them I have not always time to put them back in their proper places, consequently when I look for them on their accustomed shelves I cannot find them. There are two things I might do. I might worry myself because I cannot find a book, and I might spend a great deal of time in searching for it, and very likely lose two hours, for among a multitude of ill-assorted books it is very difficult indeed to find one little volume. Or I may do without it and go on with my work, having the feeling that this is the reward of my own carelessness, and ought to make me more exact in replacing my books in the future. Now I have learnt to take the second course, and I have saved I cannot tell you how many hours. I know that I used to lose much valuable time when I took the first course. I annoyed myself,

and sometimes other people, by a fruitless searching, and I was worried by my inability to find them. The trouble resulted in most cases from my own carelessness, and the best way to secure carefulness in the future was to endure painfully the punishment that the carelessness had deserved. By method and arrangement, so that everything shall be in its proper place, also by taking care to do each duty at its proper time, we may avoid a great many of the worries of life. If you do not do at the right time the thing that ought to be done, very likely a host of arrears will speedily accumulate and burden you with an immense amount of annoyance of which you cannot easily rid yourself. By useful and simple method that determines an orderly arrangement of engagements and time, we may avoid a great deal of what may be justly called unnecessary worry. It is quite enough for us to bear the worries that *must* come, without making additional worries for ourselves.

There is one method, I fear still very frequently adopted, for getting rid of all the worries, and anxieties, and burdens of life. It is possible to ensure a temporary insensibility to cares and troubles of all kinds by the use of narcotics. The various preparations of alcohol have long been credited with the power to "drown dull care." It has been further imagined that these alcoholic mixtures have some peculiar potency in allaying nervous irritation and producing a calm and

placable temperament. Now, no one doubts that a certain dull good-naturedness can be produced in many cases by the administration of alcohol. But we must not suppose that this effect is the result of some gently-soothing and healing virtue. It is caused by the poisonous action of alcohol, which benumbs and deadens the whole sensibility, and which consequently tones down and calms nervous irritation and excitement. There are some people who would refuse almost nothing when they have been primed with half a bottle of wine, or two or three glasses of something stronger. When our mind is distressed by burdens and cares, it is very easy to relieve it by pouring into our body something that has this influence. Please to observe that I am not questioning the relief which is gained. If a man is very much worried and troubled, and takes a sufficient quantity of strong drink, he will soon escape from all annoyance by the loss of consciousness. I admit, without the least hesitancy, that that effect is produced by the introduction of spirits. Only, let any who is tempted to make the experiment remember that he will get rid of present pain at the expense of more or less permanent injury. He must pay heavy interest, and if transactions of this kind are frequently repeated, sooner or later there will be bankruptcy. There is however, one other reason which, in my judgment, is a very strong one, why we should not indulge ourselve,

in this forgetfulness. Let a man come to believe that he can in this way easily get rid of the consequences of his own foolishness, and he becomes less indisposed to multiply his follies. There is no more effectual snare of the devil than this confidence that we can effectually escape the present consequences of our sin by drugging and stupefying ourselves. We are thoroughly taken in his toils when we are emboldened in wrong-doing by the imagination that there is an easy and sufficient remedy always at hand. There are no feelings, however unpleasant, from which we cannot be free if we are content to become "past feeling." We have it in our power to destroy consciousness; but then, is it safe or wise to exercise this power? Cases are not infrequent in which there is a persistent course of foolhardiness: fatigues, excitements, worries are made endurable by the depressed sensibility of almost continuous intoxication, until suddenly physical bankruptcy ensues, and life is extinguished almost as if by a lightning flash. Far better face the worry and suffer it even to the uttermost than have recourse to any such dangerous method of storing it up until by its accumulation it becomes fatal.

Let me assure you that we can to a large extent lessen these worries, by acquiring the very valuable habit of forgetting them. Some people talk about the use of memory. I am inclined to speak in praise of the art of forgetfulness. It is very advantageous to be

able to forget. There are some things we need to remember, and it is important to have the faculty of calling to mind the useful lessons we have learned in the past. But it is important to forget the unpleasant things, and the things that it will do us harm to keep in mind. And it is also important to acquire the art of throwing off our burdens and cares so soon as we put off the harness, and enter into the sphere and enjoyment of home life. When we leave the toils of the day, we should bring the mind into a fresh atmosphere. If it be possible, let it bathe itself in a Lethe river that shall flood out all the crosses and cankers that have been irritating it throughout the day. I believe that this forgetfulness can be cultivated to a very large extent. While we are engaged in our daily duties, let us throw our whole soul into the performance; but as soon as the hour of cessation comes, let us sturdily thrust out of doors all business thoughts and anxieties until the time comes for readmitting them on the morrow. It will add to the length of our life and the healthiness of our body very largely if we gain this power. I maintain earnestly that it is very possible to gain this power, and, partly in proof, partly in illustration, I venture to suggest one method. Have some other pursuit that will occupy the mind fully and healthfully, to which you can betake yourself as soon as you throw aside your ordinary daily task. Many find it serviceable to cultivate their own little garden,

or engage in some other kind of work, when they have escaped from the city. All should seek some kind of wholesome employment that will occupy their minds, and free them from the cares and anxieties of city life.

I venture to say that for most young men some well-selected subject of study would do this very effectually. Some may possibly prefer to engage in gymnastic exercises, bicycling, &c. Well, anything that strengthens the body is of great value. But do not forget that while we have the muscles exercised we need also to exercise the mind. There are mental pursuits that yield pleasures of the highest kind. Mental enjoyments are quite as real and quite as desirable as physical recreations. It only requires experiment to prove the truth of this statement. Only let me caution you that reading must not be merely for pleasure's sake. I am not going to enter here and now upon the subject of novel writing or novel reading; but I do say that any one who reads merely to enjoy the sensational incidents of a tale, or to have his feelings moved by passion, instead of strengthening himself for the duties of life, is really weakening both mind and body. Many of the novels of the present day are purely sensational, and may be useful reading for mathematicians and logicians, or those who are ordinarily engaged in the study of some abstract truths. For such men sensational stories may occasionally

be good as alteratives; but for those who are engaged in commercial pursuits they are of no such value. For removing their minds into a better and more wholesome sphere, some book that really requires mental effort and thought will prove most serviceable. Have some special study that will occupy your spare hours pleasantly. This need not at all interfere with the due exercise of the muscles. Most of you could secure two hours a day for instructive reading, while at the same time you are careful to devote a sufficiently large amount of time to the well-being and wants of the body. I do not mean that you should settle down doggedly to one book for three or four months' continuous study. I am not inclined to prescribe any particular book, much less one single book; each one has his own tastes and inclinations. But take any instructive book, and follow up the various lines of thought and inquiry that are suggested by it. Suppose one chooses Macaulay's History. He finds some reference made to an event which the History itself does not explain. Follow out the subject fully, and get another book that will give you detailed information. In such a city as this there is no lack of opportunities; you may gain access to books that will give you almost any information you seek.[1] Such a method of study is of more value than simply sitting down to one book and doggedly reading it

[1] In the Reading-room of the British Museum.

straight through from beginning to end. *Study one subject throughout a great many books.* In that way you have sufficient variety given you, and the interest deepens and grows as you proceed. Then take another subject. Have two or three irons in the fire if you will, and keep them all hot. Go on with a number of different studies steadily throughout, not months, but years, and besides the information you gain, which cannot be insignificant, you will cast off the worries and cares of business, and do much to keep both body and mind in a healthy and vigorous condition.

I would not be acting fairly towards you if I did not add that there is one method of meeting the worries of life that is better and stronger far than any to which I have alluded. One who had his own worries, and these not a few, and who was as much tried as any man, perhaps, that ever lived, said: "I have learned, in whatsoever state I am, therewith to be content." You know the school in which he studied. "I can do all things through Christ which strengtheneth me." It is a grand thing to approve ourselves to our fellow-men. It is a grander thing to approve ourselves to our own conscience. It is noblest and best of all to approve ourselves to God. If we know that we are doing our truest and wisest sincerely, that, with all our weakness and frailties we are striving toward the mark for the prize of the high calling of God in Christ

Jesus, we have confidence that God, who knoweth the heart, is acquainted with our whole action, and that we are, through grace, approving ourselves unto Him.

And especially when we remember that this life is simply the vestibule to eternity, and that the future vastly outweighs in importance the present, then we shall be able to bear the trials and sufferings of this transient life calmly, knowing that God is able to make His grace sufficient for us, and that He perfecteth His strength in our weakness. Remember, I am speaking as a physiologist, not as a theologian—simply from the standpoint of physical law and truth. If I were preaching a sermon I would enlarge on this and show how the gospel of our Lord Jesus Christ enables us to give the right weight and value to everything earthly, and enables us to meet the *disciplinary* trials and afflictions of this life without a murmur, knowing that we have in heaven a better and a more enduring substance. Nothing can make us stronger to meet the worries and evils of this life, nothing conduces more to healthiness of body and mind—still speaking physiologically—than faith in the power and presence of God, and the assurance that with all sincerity, and humbleness, and meekness we are endeavouring in the grace of the Lord Jesus to serve and please Him.

IV.

REST AND SLEEP.

I AM not prepared to take exception to the old adage, "Better wear out than rust out." And yet I show unto you a more excellent way. I think there is no reason why, in avoiding the rock, we should sail into the whirlpoool. It is quite possible to do the utmost of which we are capable in the performance of work without injuring either the tissues or the functions of the body. I have already spoken about exercise, and the value we attach to it in maintaining the body in a healthy condition. I have to speak now of the importance cf rest, and specially of the importance of sleep, that we may be able to continue the exercise of these functions throughout our life healthfully and well.

There are some who seem to pass their lives in a state of lethargic repose. They have no object in view, and they seem only to be anxious to consume the time that otherwise would hang heavily on their hands. There are not many conditions in life more pitiable than this. Stagnation of this sort always issues both in

bodily weakness and in mental imbecility. There are others to be pitied, perhaps not to the same extent, but certainly to a very great extent indeed, who, with a capacity for labour, and with a longing for some useful employment, are, by the necessities of their position, shut out from engaging in any active and engrossing occupation. These are exposed to great dangers. We think of the couplet with which we are familiar:

> "Satan finds some mischief still
> For idle hands to do."

The truth to which Dr. Watts has given expression has been proved over and over again, in thousands of instances. Where the energy that one naturally possesses is not allowed to find a proper channel for its exercise, it often makes very inconvenient and wrong channels for itself. There is no state in life more conducive to our well-being physically, mentally, and morally, than that in which we find full and regular employment for all our powers.

The continuous taxing of our energies produces, as a natural result, fatigue or weariness, with a desire for repose, and a preparedness for the enjoyment of repose. I do not know that we are able, physiologically, to indicate the conditions on which rest and sleep depend for their restorative value. I think I can use an illustration, however, that will be adequately helpful, and in connection with which I shall not be obliged to

frame any theory. Let it be assumed that we wish to have a sufficient "head" of water to turn a mill-wheel, at definite times, for the production of certain results. There is a small stream of water available, not sufficient of itself to give us the full power requisite for the motion of the machinery. We collect the water in a reservoir, by degrees, throughout many hours, and when we have gained sufficient volume, we turn it on to the mill-wheel, and thus produce the revolution required, which sets all the rest of the mechanism in motion. When we have exhausted the reservoir, of course we must then wait until, by the action of the stream, we have the reservoir replenished. Then we can again commence the same operation, and cause the wheel to revolve. Somewhat after that analogue it would appear that energy accumulates in the body for the performance of useful work. When a gland or a muscle or the brain has been exercised continuously for a definite time, it begins to flag; its power for work diminishes. It becomes feeble and unfit for the continuance of its functions. But if its action be suspended, and time given to it for rest, it seems to gain afresh, slowly but surely, a sufficient amount of energy to resume the work we have intermitted. We are able, somehow or other, by alternating repose and action, to continue successive actions, with certain intervals between, throughout a long life.

It has been much debated by physiologists whether

this need of rest depends upon the necessity for stillness in order to the nutrition of the organs, or whether it depends on some other cause. It has been argued by some that during exertion there is waste, and that during the period of quietude there is a building up or replenishing of the muscles or glands that have been exercised, and that on account of this need for the recuperation of tissues that have been wasted we have rest alternating with exercise. For my own part I can scarcely see that this supplies a full explanation of the problem, because there is undoubtedly *continuously* carried on in the body a contemporaneous process of waste and repair. We are losing and gaining at one and the same time throughout our whole existence. We are parting with material, and we are adding new material, that takes the place of that which has been lost simultaneously. But if you recur to my illustration you will find it possible to conceive that there may at one time be a greater amount of waste than there is of repair, and at another time a larger amount of repair without any corresponding waste. There may be a storing up at one time which balances a larger expenditure at another. This I think, as nearly as I can express it, gives the physiological reason for rest, so far as the body is concerned, and I believe, the terms being changed that require to be changed, it explains also the need of rest for the mind.

So far as we know, there is not any part of the body

that is not subject to this law—that does not require, in some way, to have amends made to it for its loss of power in action by a period of repose. You may tell me that there are some functions of the body that are continually in exercise. We are always breathing, whether we wake or sleep. The heart is always beating, whether we are engaged in strong powerful exertion, or resting and lying down. That is perfectly true, and yet if we examine these functions, on which life so eminently depends, we find that there are periods of repose for them, as well as periods of active labour. If we investigate the action of the heart, we find a short pause follows its stroke regularly and always; so that while it continues to perform its allotted task steadily throughout a period of twenty-four hours, when we sum up all the separate periods of repose it has had during that time, we find that they amount to eight hours. Thus the heart actually gets, in small and divided doses, but really gets, eight hours' rest every twenty-four hours.

And it may be taken as a general rule—although I do not deduce it from this fact—that all the different parts of the body require a somewhat similar period of repose, to make up for the loss of energy during active employment. If we divide the day into three parts of eight hours each, eight hours may fairly be given to real, sturdy work—not playing or trifling—eight hours to sleep, and eight hours to miscellaneous—well, say

eight hours to special service to our fellow-men, to special intercourse with God, and to the holy, healthful enjoyment of life. And I believe the enjoyment of life is found in fullest force when the day is spent as I have indicated.

You are aware that we are able, in process of time, as the result of experience and habit, to do certain tasks with a great deal less effort, and consequently with much less weariness, than when we first attempted them. We gain the power of doing them more simply, and consequently with less loss of strength on our own part. I believe that arises mainly from this: that we gain the power of alternating action and repose. Just as in the case of the heart, which, in its beating and resting alternatively, secures sufficient time for recovery between the beats; so we, by working steadily, and yet with a certain measure of slowness and deliberateness, are able to secure for ourselves, right through the continuous labour, a large amount of rest. We may thus gain no inconsiderable addition to the longer rest of eight hours that we get at the end of the working day. A good workman can do more work, and better work, with far less fatigue, in eight hours, than a bad workman can do in the same time. By husbanding his energies, he can sustain a steadier expenditure of strength than one who has not gained that experience or power. And it is important that we should learn thus to employ the strength that we possess.

Hurry and hard driving are not conducive to the best results. A workman never loses the time spent in sharpening his tools; and anything that gives us a greater "head" of power, and that enables us to employ it effectively, is really not only an economy of time and labour, but adds largely and profitably to the results that we reach. So that our care ought to be given to working in such a way as to secure that our labour shall be attended with the least disadvantage, and that we shall not expend more energy than is actually requisite for the production of the end desired. And I believe one reason why alcohol is found to be so injurious in many cases, although it seems to produce more expenditure of energy, is just because, through the decrease of sensibility, it leads the man to put forth far more energy than is requisite for the accomplishment of his task. Under its influence he really wastes power needlessly, and does not attain the same result, at least, never attains it with as little fatigue, as the man who does his work carefully, balancing by experience, and his power of directing his actions, the expenditure of energy that he makes.

In addition to what I may call the diurnal periods separating between work and rest, there is a demand, after a certain time, for longer repose. And you may notice this in illustration of both facts, that all spasmodic efforts—all efforts in which there is even for a short

time continuous action in one direction—are much more fatiguing than others in which there are slight alternations of action and rest. For instance, if I hold out my arm at full length, balancing a weight at the end of it, I find in a short time that the muscles exercised in sustaining this effort are wearied, and I am obliged to lower my hand. I could use these muscles in performing an operation requiring a great deal more care and power, for a much longer time, without producing the same fatigue. The muscles, in the first case, are put on the stretch, as we say, and kept thus, without any alleviating alternation. Throughout a certain period they are steadily taxed by this contraction, and consequently they have no opportunity throughout that period, longer or shorter, of gaining any rest. But in alternating contraction and relaxation we have a period of repose following the period of effort, and we are able to work much longer without the same amount of fatigue. All efforts that are carried on continuously, without break or change, are much more injurious and much more wearing out than efforts that are balanced somewhat by moments of relaxation, however short. And there is nothing that is more hurtful to the heart than any cause that flurries it, and produces a continuous beating, which hardly allows it time to gain the momentary repose to which it is entitled. A great many diseases of the heart, functional and organic,

are produced in this way. The same rule applies to the action of other parts of the body. For this reason, if any of the secreting organs are employed continuously in doing work without a period of repose, they are much more likely to give way and break down than if they have a stated amount of work to do, with a fair period of rest assigned to them. They ought not to be irritated by unremitting task-work. The various glands that are concerned in digestion—especially in the case of those who suffer from digestive weakness—are much more likely to suffer if stimulated to action continuously, and without intermission.

In addition to these securities for careful measurement of the force expended, and these provisions for momentary rest during the time of action, we need repose of a more lengthened and definite character. At the close of the day's task, assuming that we have not been trifling, but really working, we require rest, and it is well for us to take it, and to take it fairly. Only do not let us suppose that rest means simply throwing ourselves down on a couch and relaxing muscles and mind indolently by the mere quietude of body and brain. We may be refreshed no less effectually by calling into play other muscles or other mental faculties hitherto unexercised. Indeed, we only do *them* justice in giving them a definite opportunity for working. We may, in this way, not only allow the fatigued parts to recover energy, but we also

secure the due action essential to the well-being of the other parts. Students are familiar with this fact, that they can give rest to the mind just as effectually by changing the subject of study—passing from one department of thought to another—as by absolute idleness. Indeed, the attempt to cease from thought altogether is oftentimes futile. When we shut the book on which we have been engaged, and sit back in our chair determined not to think at all for the next hour or half-hour, either of two things will probably happen. We will fall asleep, or we will continue to pursue the line of thought already present, and in the latter case we will fatigue the mind as really, although not to the same extent, as before we closed the book. But if we open another book on another subject, we lift the mind on to a new line of rails, if I may so speak, and it will proceed freshly and with recovered elasticity in the new pursuit. I do not pretend to explain this mental peculiarity, but I know it to be a fact, and any one can prove it for himself by making the experiment. We are thus enabled to give renovated attention to a new subject, although the mind has been weary and confused by long-continued attention to another subject.

And this is even more fully exemplified in the body. If we have been exerting the muscles of the hand or arm in doing work, we can rest them, while using the muscles of the leg. Suppose I have been writing all

day, using the muscles of the thumb and the fore-finger and the wrist; I have tired these muscles, and I have also expended a certain amount of nervous power. For it is a very foolish thing to say that hand-workers are not brain-workers. No man can work with his hands without using his brains—that is to say, his nervous energy. There is no labourer in the field who does not spend nervous energy, and who is not truly, though it may be in a humble sense, a brain-worker. In the case to which I have alluded we can change the parts that are being exercised by taking a long walk, or engaging even in some vigorous game.

People who are wearied by the day's work are not unwilling to have a hearty run in some exciting sport. Other muscles are called into exercise, and there is, in most cases, a sufficient store of nervous energy to find outlet in the new channels. And they find a joyous interest in friendly contests that give zest and pleasure in the new task. It is to them really rest, and it is also a much better kind of rest than if they were simply to throw themselves down on the grass and do nothing. We can thus rest ourselves effectually by working the other muscles, or other parts of the body, in new directions.

It is well to remember this, because, as I have already hinted, it is advantageous that we bring all the different parts of the body into healthy play at some time or other during the day. It is one of the great

aims of a well-conducted gymnasium to have the muscles that are least likely to be employed, or employed for healthful ends, brought into active exercise. It is of some consequence that we neglect no single part of the whole frame; but it would be very foolish to ask the postman, who has been trudging all day over the London streets, to take a walk and join you in an evening stroll. He has had enough of walking. That certainly will be to him neither rest nor recreation. If we call into play any of the muscles during the period of rest, we must take care that we do not so employ any of the muscles or parts of the body that have already been taxed to their utmost in doing the day's work.

But in addition to that we require at the end of the day the rest given to us in sleep. Sleep seems somehow or other to minister fresh energy to the nervous system. If you take up physiological treatises in the hope of finding out all about the nature of sleep, and the causes of sleep, you will be very much disappointed. The truth is, we know very little about what I may call the *rationale*, or the theoretical part, of the subject. We know very little about the ultimate physiology of sleep; but we know a great deal about its actual condition and effects. We know at all events that, somehow or other, a period of sleep, in which there is the cessation of ordinary sensibility and of the action of the will, is required in order that the nervous system

may recover its tone and tension for the performance of its work on the morrow. And that is provided for us regularly, by organic necessity, every twenty-four hours. Sancho Panza said, "Blessings on the man that first invented sleep. It covers men all over, thoughts and all, like a cloak." So it does. And it is not merely an enjoyment and a luxury, it is a necessity of life, and is imperatively demanded like food and drink. It is just as needful for the continuance of healthy life as are the other things on which we depend for the maintenance of the body's structure. No torture is more distressingly painful than the torture that results from continuous deprivation of sleep. In olden times we read that this was occasionally employed. It was one of the most trying, most awful, and most excruciating agonies to which poor mortals have ever been subjected. Indians have been known to sleep during periods of torture, when tied to a stake and being slowly burned. There is a case on record of a man who was stretched on the rack and exposed to most severe pains, who yet slept during the intervals when the suffering was not so excessive, and he complained bitterly that the most painful of all his agonies was the shortening of his opportunities of going to sleep.

Sleep does indeed act as "tired nature's sweet restorer." It "binds up the ravelled sleeve of care," it is "dumb labour's bath," and after we have passed

through helpful unconsciousness we are enabled to resume vigorously the duties of life.

I dare say you have watched people, under certain circumstances, trying to go to sleep, or rather going to sleep without trying. It is amusing to find in reading books on sleep that almost all writers are agreed in saying that one of the means most conducive to sleep is sitting in a close, warm church, listening to a dull sermon! Unfortunately, there is too much truth in this statement; and if we could get rid of the closeness by ventilation, and if we could also eliminate the dulness from the sermon, it would be better, of course, for our church life and our Sabbath exercises. But sometimes you have noticed in church a good Christian man—for Christians are subject to the frailties of the body as much as others—strenuously resisting the inclination to take "forty winks." You will have seen his eyes gradually close, his head begin slowly to fall, till it goes down with a jerk. Immediately his head is up, and he is staring round as if he were the most attentive listener in the whole congregation! A curious drowsiness comes over good people in the quiet and restfulness of the church pew which they find it almost impossible to resist. I have known of cases in which sharp points have been driven into the flesh to secure wakefulness, and even this extreme measure has proved a failure. There is a determination not to yield to this lethargic

tendency; yet, in spite of all their well-intentioned efforts, this drowsiness prevails. In these cases you can perceive how gradually sleep seems to "fall" upon the man. You know there are muscles in the neck that are employed in keeping the head erect. From these the power, as sleep approaches, gradually fades away, and consequently the head ceases to be upheld in the position of wakeful attention. It begins, as I have described, to nod, and when the power is completely withdrawn the head falls down. And the sudden falling of the head is sufficient, at that stage, to waken the sleeper, and cause him to exert himself in renewed resistance to this dulness that is creeping over him. If we could watch ourselves—though it is not desirable to make such experiments, because the watchfulness, even if it were possible, might interfere with healthful sleep—we would find this process repeated in our own experience very exactly every time we go to sleep. There is a gradual loss of consciousness, and a gradual relaxation of the muscles under the control of the will. There is a gradual loosening of the connection between the volitional centres—if you will allow me to use the phrase — the powers of control that we have over the different parts of the body. In fact, the whole machinery is thrown out of gear by the removal of this voluntary direction and control. That takes place gradually, and it is suggested that in all cases of sleep it is simply a question

of degree, that there is still more or less connection, and that it varies during the time of sleep. Instead of sleep being one continuous thing, it is supposed to be a varying condition, in which periods of more and less connection between these centres of control and the different parts of the body alternate with each other. In what we call deep sleep—thorough healthy sleep—there is an entire cessation of any interference of the mind with the body. I am not saying that the body does not continue its functions: such a statement would be incorrect. The breathing of the lungs and the beating of the heart go on still, and other actions of organic life, although more slowly than during waking hours. Nor am I saying that the mind is inactive. There is such a thing as dreaming, in which the mind is curiously awake and curiously persistent in its inroads into different realms of imagination and fancy. But the connection between the mind and the body is for the time disturbed, and our will seems to cease its action on the different parts of the organism. You have felt thus when asleep during the progress of a dream. You imagine you are in circumstances in which you are exposed to some great danger; you are about, it may be, to be killed, and yet you are utterly unable to stir hand or foot to save yourself from the dreaded danger. You are unable to cry out; and it is one of the most painful experiences to find one's self so utterly helpless when we think

we are exposed to the most deadly peril. There is the absence, even during the imperfect consciousness of a dream, of this power of control over the body and its motions.

I cannot go into the different questions that might be raised in connection with dreaming, because not only are they very numerous, but they are also very intricate; and I do not suppose we have yet gained any such actual knowledge of the subject as must precede the possibility of a fair and complete explanation. I do not think that any theory is plausible in which it is maintained that the mind is so identified with the brain that the brain substance, by its own activities, adequately accounts for the phenomena of dreaming; nor do I think, on the other hand, that any theory is plausible in which it is maintained that dreaming is simply an action of the mind, without any relation whatever to the nervous system.

Let me return, however, to sleep. We have noted, apart from dreaming, this loss of control on the part of the mind or will over the different parts of the body. There is also, as I have already stated, the absence of ordinary sensibility. We are not conscious of the things that are taking place around us, that in other circumstances would attract our attention. Of course the eyes are closed, and we cannot see. The ears are not stopped, and yet we cannot hear. The skin is still free to be acted upon by touches from

without, and yet our hands may be moved, and often some slight injury done to them, without our being aware of the action. Our nostrils are still open to receive odours, and yet there may be very strong odours in the room without our being aware of their presence. The senses are apparently without sensation, and the action of things outside does not affect us as during our waking condition. I believe in these facts we have really all that is known at the present time in regard to this condition that we call sleep.[1] There is a shutting off of our sensibility—a disconnection between the will and the different parts of the body that it ordinarily controls—and in these circumstances the nervous system gains its rest. For what is its ordinary action? It is mainly employed, during our waking time, in carrying messages and in giving effect to messages by the liberation of energy; it is under the control of the will in setting free forces in different parts of the body; and it is employed also in carrying messages to us from without, by means of the different senses. When we have shut it off in sleep from both kinds of messages—from bringing messages in and from carrying messages out—we are giving it rest. In that way it is able somehow by nutrition to recruit its energy, and to regain sufficient force during the night for its duties on the coming day.

[1] Somnambulism is a condition markedly different from natural sleep; but to this peculiar abnormal state I do not now refer.

Next, as to the *time* of sleep. Of course you will find it said very gravely that the proper time to sleep is during the night; and there are indeed good reasons why the night-time should be devoted to sleep. In the first place, in the darkness and in the quietness of night the senses are more easily closed to outward things than during the brightness and activities of the day. The circumstances are more favourable to repose during the time of darkness than they are during the time of daylight. And that is a very good reason indeed why people who find it difficult to gain a proper amount of sleep should be careful to take it at the time when all the surroundings conduce to easiness of entrance upon this condition. But then, on the other hand, there are people who are able to sleep as well, and who find it necessary, because of their duties, to sleep only during the day time. And it is possible, by the conditions in which we are placed, and by habits which we are obliged to form, so to regulate our action that we can take our sleep in small doses, as I have spoken of the heart getting its rest at intervals. In the case of those on board ship, and of men similarly circumstanced, it may be necessary to restrict the period of sleep to four hours at one time; and yet with this short repose, granted, of course, at sufficient intervals, they may maintain a healthful and vigorous life. So that it would appear—although, for reasons I have already stated, the night-

time is best for our gaining full rest in sleep—we may get a sufficient amount of it in other circumstances. The one thing essential is that we do get thorough repose for the nervous system; that, for a period varying from five to eight hours, the system is allowed full opportunity to recover its activity. There are cases on record in which men have been able to exert themselves during many years with a very small daily allowance of sleep. It is said that John Hunter, the celebrated surgeon, never slept more than five hours out of the twenty-four; and General Elliot, during the siege of Gibraltar, slept only four hours out of the twenty-four. The time spent in sleep may vary, within the limits, say, of five to eight hours. In childhood a larger amount is necessary. The child that sleeps well thrives well, and a very large portion of the day as well as the night is spent by a healthy infant in sleep. It grows remarkably by means of this *waste* of its time, as some would say. But the time is not wasted, because the child is being built up for doing its work in after life. At that period of life sleep is the best employment in which it could be engaged. Depend upon it that things of this sort, although we are inclined to look upon them as waste and loss, are not waste and loss if they fit us for our work at other times. It is really time wisely expended and well used.

I have spoken of the time for sleep and the time to

be spent in sleep. What are the circumstances that are conducive to sleep? Fatigue and weariness, when not excessive, dispose us to sleep. We may so fatigue and weary ourselves that we cannot sleep, and there are few conditions more difficult to deal with than sleeplessness produced by over-exertion of brain or body. A certain amount of work is needful, in order that we may gain good, refreshing sleep. There are some lazy, lymphatic people who are able to sleep almost the whole of their time, but I do not suppose that they gain much by it; it certainly does not make them stronger or wiser. Those who are able to sleep well and thoroughly after working well and thoroughly find that the exercise, on the one hand, strengthens body and mind; and sleep, on the other hand, maintains the power to continue work steadily throughout the whole duration of their life. In cases in which we are troubled with sleeplessness from any cause, it often becomes a question of very grave importance what we should do to remove it. There have been a great many recipes suggested, but I think they all depend mainly on our being able to put ourselves into the circumstances in which naturally sleep occurs. Sometimes we are told to count a hundred, then begin to count another hundred, and so on until we fall asleep. That is sure to succeed if we go on long enough! I believe it does succeed, in a short time, in a great many cases. We are told, at

other times, to think of our breathing, and follow the breath in imagination as it goes out and as it comes in. We are told, again, to think of an interminable flock of sheep going through a hedge. Anything that will take our minds away from what may be exercising it, and fix it upon some monotonous theme or subject—anything that will arrest its activity and fix it somewhat vacuously—is undoubtedly conducive to our going to sleep. All these recipes depend on that fact. If we are able to withdraw ourselves from outer circumstances, and free the mind from harassments, and burdens, and cares, we naturally get into the condition in which repose comes. When we lie down on our bed, we put ourselves in the posture in which sleep can most successfully woo us. The limbs are relaxed, the head is laid down, the whole body is at rest. We ought to lie, I think, on the right side; although of course there may be conditions in which the left side is preferable.[1] Of course we ought to shut our eyes. And I think it would help us if when we desire to induce sleep we began to breathe deliberately, and very much after the manner that we notice sleeping people do. They breathe very much in this way (illustrated by a lengthened inspiration, followed by a somewhat abrupt expiration). If I sit down in my chair and wish to sleep, I begin breathing in that way,

[1] For instance, when the left lung is obstructed, and it becomes advisable that we give fresh play to the healthy, unobstructed lung.

and let my head rest lightly on the back of the chair, and I can go to sleep within a very few minutes. I have that power—I do not know whether it is an enviable one or not—of going to sleep any time of the day, when I feel it desirable to do so. When in good health I find that on going to bed I fall asleep within a very few minutes, and I generally do not wake again until it is time to get up. I find six hours' full sleep quite sufficient for my wants. If I have any extra work I can take an hour or half an hour, as the case may require, in the course of the day. I very often do that, particularly when I have to speak in the evening.

Then, again, in order to induce sleep, particularly in the case of invalids, it may be advisable in some instances, to get some one to read quietly for some time. The monotonous hum of the reader, especially if the book is not very interesting, going on for perhaps half an hour or an hour, is quite sufficient in a great many instances to produce somnolence. These things are not to be despised as remedies for sleeplessness in certain circumstances, but what we ought to depend on mainly for securing sleep at night is the fair exertion of our powers during the day, mental and bodily. It is needful, too, to keep the mind free from worry, so that nothing on the mind may prevent sleep. Agitation, alarm, distress, grief—these things prevent sleep just as surely as bodily pain, and it may be as

desirable to use means to allay harassment, or worry, or grief as to remove pain. It is of very great importance indeed that these things be taken out of the way. I make it a rule that such work as I engage in before retiring to rest is of the simplest and easiest kind. I do not go to bed very early, but I never work hard after ten o'clock at night. I do read a good deal, but I do not read anything that requires much mental effort. I keep all my hard reading for the middle of the day, the working hours; my writing and anything that requires mental effort I keep for the proper time, but before retiring to rest I always read something that does not call for any vigour of mind or exertion of thought.

In cases of persistent sleeplessness may we have recourse to narcotics, such as opium or alcohol? That is a very grave question, and demands a careful answer. Let it be freely admitted that for the relief or removal of pain it may be allowable to administer substances that dull or deaden the nervous system; and that when pain prevents sleep there may be a fair argument for their administration. The question still remains, may we, in the absence of this indication for their employment, give them simply for the purpose of inducing unconscious repose? Now let me note here that there are two kinds of sleep. In normal healthy sleep the vessels of the brain are comparatively empty; in narcotic sleep

these vessels are full and swollen. The conditions are opposite. We know that in the one case the sleep is refreshing and restorative: we may be at least allowed to doubt whether it can be so in the other. No one will contend that the first condition is not much more desirable than the second. In these circumstances it can at least be confidently affirmed that opiates are not admissible except as a *dernier ressort*, and even then we cannot be quite sure that they will prove of any real advantage. And there is besides, the danger—never more urgent than in the present day—of their occasional use leading to a rash, reckless, and habitual employment of them.

Let me say here—I think it important—that there is a very universal tendency to argue that we ought always the last thing at night to read God's Word and engage in prayer. I know that there are something more than sentimental reasons for it—"Begin and end the day with God." I can see good reasons, if we are in a state of mental and bodily vigour, for doing both. But in many cases these are the very worst hours in the day, when we have least time, and when we are least able to enjoy and get benefit from God's Word, and when we are least able to speak to Him faithfully and freely. The principle on which I would insist is, that the best of our time and powers should be given to those highest privileges. For my own part I do not care to make my

weariest hours the hours in which I shall draw near to Him, and commune with Him, either in prayer or in the reading of His Word. Something that will not call for much mental exercise, that will allow the mind to be restful, something pleasant and easy to read, or conversation that is quiet and agreeable; something of that kind is the best physiological preparative for going to sleep.

But we require something more even than *daily* rest and sleep—the *weekly* Sabbath. I am not speaking here as a theologian or preacher, but simply as a physiologist, and I say the Sabbath is just as much a physical necessity at the end of the week as sleep is at the end of the day. We are in this matter somewhat like an eight-day clock—we require to be wound up once a week. We need not only the intervals of repose given to us each day, but we require the supply of refreshment and energy that we gain by resting one day in seven. Personally, I make it a rule always to rest *one day* in the week. I take the Jewish Sabbath, simply as a convenient day. I cannot get the Christian Sabbath, because that is one of my working days, but on Saturday I never do any duty requiring effort. I never exercise my mind or my body in any way that I would not do on the Lord's day if I were a private Christian. I make it a complete rest-day, for I must have one day in seven to keep the body well; and I attribute to this in no small degree the

fact that I am able to go through a pretty large amount of mental and bodily work without fatigue or breaking down.

A very well-known man in the last generation, who had in his hands to a large extent the control of travelling in Ireland, Bianconi, who carried the mails throughout that country, gave it as his deliberate conviction that he could work a horse eight hours a day for six days more safely and with better results than he could work one six hours a day for seven days. That is to say, he could get forty-eight hours' work out of the animal in a week, by giving it only six days' work out of the seven, more safely and economically than he could get forty-two hours' work by working it seven days a week. I believe that holds good universally, for the law is not merely for man, it is for animals too. We are to give them rest while we take it ourselves. It is a law of the animal creation just as much as sleep is. Indeed, sleep, strangely enough, seems to be needed by plants as well as animals. Linnæus observed that certain plants shut themselves up, and really seemed to go to sleep at night. This need of rest is co-extensive with organic life; and the need of one day's rest in seven is co-extensive with animal life.

People tell us that the Sabbath ought to be given to pleasure, and they insist that they are the friends of the working man in maintaining that it should not be

so exclusively kept as it is to what are called gospel observances, or spiritual enjoyments. I venture to say, after deliberate study of the subject for many years, that if you take away this sanction from the Lord's day, you have no security for its preservation in any form whatever. It is in the interests of working men that we insist upon the Lord's day being kept sacred from work of all kinds. I have no desire to coerce people; if their own conscience allow them, let them employ the day as they please, but they must not make other people work for their pleasure. It is a very hard thing that the enjoyment of the many should be taken at the expense even of the few. We have had a great many pictures given to us—very sentimental pictures—of the necessity for Sunday trains, in order that physicians may get to their patients in the country. Let me whisper that it is quite possible that the visit of the physician may not affect the issue. We are also told that the dying wish to see their friends before they die, and if we close our railways on the Lord's day, we hinder this desirable visitation. But people have dying friends who are separated from them by seas and continents, and they cannot go to visit them in such circumstances. They have to bear the hardship. There are cases, too, in which physicians are so far removed from their patients that they cannot reach them within twenty-four hours. I do not think these reasons can

hold good or stand examination, considering how very rarely such things must happen. And when we remember that in this great city in which we live, the work of the Post Office is intermitted regularly every Lord's day without any loss or complaint, we have a full answer to all the difficulties that may be raised on the other side. Mark you, I am simply contending here in favour of rest for all. I am not debating the question on religious grounds, or on sentimental grounds, but simply on the basis of the physiological necessities of animal life; and I contend that the best interests of the community demand an entire and guaranteed rest for one day in seven.

It has often seemed strange to me that those people who are so anxious to draw men out of the public-houses into museums on the Lord's day do not set about shutting up the public-houses on that day. That would be a very great gain. But they do not seem at all so anxious on that side of the question. And I also wonder that they do not exert themselves more to secure that the Saturday half-holiday be made available for visiting museums. A great many of these wholesome places of resort are shut on Saturday afternoons; why don't these friends of the operatives make special provision for having them open, and getting the working men into them? They do not seem to begin at the right end, and there is a warrantable suspicion engendered that it is

not because they love the working men more, but because they love the Sabbath less. Our only security for the continuance of this rest is the security given in God's Word.

V.

FASTNESS.

THROUGHOUT the livelong day our City is thronged with busy men. They hurry along its streets and crowd its rooms of commerce. Detained within its limited area by a strong force, having many differences, and many separate interests, they are yet all united by one bond—work. But when business has loosened its strong grasp, by road, and rail, and river, they depart to other spheres. When night falls the City becomes like a city of the dead, and those who filled it during the day are intent upon the occupations or amusements which they love. And their leisure is the test of their character. How they employ their time when they are free from the cares and concerns that fill their working hours, determines the state of their minds and the state of their hearts; and if you could tell me where they are to be found, night after night, I could unfold to you their history much more correctly and much more completely than by any information you can give me about their labours throughout the day. It is when they are set

free to go to "their own company"[1] that we learn what they are. While we are engaged in our daily tasks we have little time for other thoughts and for other matters. These are sufficient to occupy us fully; but when we are able to do as we like, and when we betake ourselves either to the occupations or amusements that we love, then we express the peculiarities of our individual nature. And I wonder oftentimes that both philanthropists and sanitary reformers have not learned that the amusements of the people have an immense influence in determining their character, and that a due attention to these amusements, so as if possible to make them wholesome and healthful, would have a very strong and striking influence upon the well-being of the whole community.

For our temptations come in the time of our amusement and freedom. Temptation is not so busy with us through the day,[2] and the evil that is wrought to a very large extent is summed up within the time when we are free to do according to the tendencies and inclinations of our own hearts. If we could secure that the amusements of the idle hours of men were right, and rightly distributed, we would do much to edify them in strength and solidity of character. I have not a word to say against amusements, because we have a natural liking for pleasure, and

[1] Acts iv. 23.

[2] Assuming that the business is lawful and honestly conducted.

wholesome pleasure is one of the fairest bounties of our loving Creator. And although I would not esteem any man much who made pleasure his aim in life, yet God adds to our life-work the blessedness of the pleasant, healthful employment of the various faculties He hath given. Pleasure is the salt and zest of life, and while I would not exaggerate it, I would not venture to speak a single word against its legitimate enjoyment. The one thing important and essential is that all our pleasures be of the right kind; that they be of such a kind as shall invigorate us; that instead of making us weaker they shall make us stronger, truer, and nobler; and that they shall help us more manfully and thoroughly to enjoy all the gifts God in His providence confers.

I am anxious to speak very plainly on this subject; and I am anxious also not to employ words that may awaken evil thoughts or feelings. I shall speak mainly of the influence that "pleasures" of different kinds have upon the health and the condition of the body. And if I must occasionally diverge to talk of their influence upon the mind and heart, please remember that I am obliged to make such digressions because of the reflex action upon the body. You have learned that the body and the mind are so joined together that one cannot suffer without the other suffering, and the one cannot be strong without imparting some measure of strength to the other;

and therefore you will not be astonished if I speak sometimes of the morality and intellectualness of amusements as bearing upon our bodily health.

There is a natural tendency to seek those amusements that excite the greatest keenness of pleasant sensation; amusements that convey to us a fresh influx of happiness, and that exalt us, and stimulate us, as we think, to a fuller life. We have to learn this, that our bodies are so constituted that excess of every kind, though it may for the moment give an increase of feeling, tends to injure and deteriorate the organs on which it acts. Moderation is safe and healthful, but excess of any kind is unsafe and unwholesome. I am speaking now simply from a physical standpoint. The senses themselves are blunted by excess, and instead of being made more capable of doing useful work, they are lowered and lessened in capacity thereby; and the nervous system, by which we are made sensitive to pleasure, is injured and enfeebled by excess. And that injury and enfeeblement consequent on abnormal excitement narrows and lessens our power of enjoyment for the future. We know as a practical fact that those who launch themselves fearlessly upon the sea of pleasure, and are determined to enjoy to the full all the opportunities that may come to them of soliciting and seizing recklessly every available excitement, soon lose their keenness of sensibility, and have to seek

novel methods of awakening appetite, and they are sadly burdened by endeavours to regain that freshness of feeling they have lost. And the time comes, sooner or later, when even this possibility of being spurred and stimulated into enjoyment is lost. There is no sight in the world more pitiful than that of a sated sensualist, who has reached the stage in which he is "past feeling," though not beyond the habitual craving of vain desires, and from whose corpse-like body the power of enjoyment has long departed. He has ran the full career of unlawful pleasure, and has so effectually destroyed his sensitiveness that he is unable to renew his gratifications, and must fain console himself with the dim and misty recollection of what he loved and liked in the past.

Depend upon it, the one way to secure that our life shall be enjoyable throughout is to keep the sensibilities keen, to maintain the power of enjoyment that God has given us fresh and strong. Thus we shall be able to reap repeated harvests, and to enjoy throughout a long life all that our Father has provided for our comfort and well-being.

In so speaking I am simply indicating a natural law of animal life. The nervous system gets degraded and injured in tone and in power by any *excess* of enjoyment that may be forced upon it. It loses in consequence steadily, and in an increasing ratio, the power of appreciating what we call the simpler pleasures.

Depend upon it, the man who contents himself with the enjoyment of the simpler pleasures is more enriched with gladness than the man who greedily satiates himself with every possible pleasure, and thus forfeits the very capacity of enjoyment before he has attained the full years of maturity. Who does not know that there are some people who remain young and joyous all their days? and these are they who have not thus foolishly hasted to gratify every passion, but who have taken healthful pleasures calmly and moderately, enjoying life none the less, while they maintained their power for further enjoyment unwasted, so that earth to them becomes full of sunshine, and they retain a genial boyhood or girlhood to the end of their days. Depend upon it, we cannot cultivate our nature too carefully in this direction. The man who sits down to a table loaded with all kinds of stimulating viands to whom these seem necessities for the excitement of appetite, does not partake of food with the same relish as the man whose keen hunger eagerly seeks the most simple fare. It is on the *appetite* that pleasure depends more than on the *supply:* on the *fitness for enjoyment that we ourselves possess,* rather than on the materials that are presented for our gratification.

If we learn the lesson contained in that last sentence we are prepared to look at this subject fairly and fully. I am quite sure that if we keep this lesson in mind

we shall be warned against many very dangerous and deadly errors.

It is a great hazard for a young man to be launched upon the full tide of a city's temptations and sins. Sometimes young men come up from the country to London innocent, or, as some may term it, ignorant—not knowing anything whatever about the various vices that show themselves so openly along our streets. Their companions talk of them as "verdant" and "missish." I revere and honour a verdant youth. His verdancy is a patent of nobility, and I pray that God may enable him long to preserve this sure guerdon of a green old age. He will not be ashamed of greenness *then*. Believe me, though there are many who laugh at him because of his greenness, and talk very scornfully of his want of knowledge, not only do good men honour him, but even wise men, who, though not good, have reaped in themselves the fruits of their own folly, *envy* and honour him too. They know his condition is the safer one, and that if he is able to maintain it, it shall be well with him all the days of his life. If there is one here who has maintained that condition amid the unblushing, sinful effrontery of London, he is entitled to high honour, and I can assure him that in the preservation of his "greenness" he will find a perennial source of gladness all his days.

But it is to be feared that in a city like this there are few that can preserve their ignorance—I do not

say their innocence—very long. We can scarcely avoid becoming acquainted with the fact that there are many sins surrounding us in such a city as this. We become to a certain extent familiar with them even though we may hate them, and we cannot altogether escape their contact and pressure. It is well for us if we are able to maintain our early abhorrence of them all our life through. We can only do that by scrupulously shunning all occasions of defilement. We cannot keep ourselves too far distant. We cannot abstain cleverly and carefully enough from the very appearance of evil. If we make it our study and effort to shun the very first beginnings of evil, it shall be well with us now and evermore. Temptation is very insidious in its approaches, and if once the defences are broken down, and we are prepared to dally with it or look at it, and give it entertainment and examination—if we are prepared to look round it and weigh it and consider it, and out of curiosity begin an investigation into its nature—we endanger our well-being in a very serious manner. If we resist the devil he will flee from us, but we are to "flee youthful lusts which war against the soul." We are to *flee* them, not to *resist* them. We must carefully guard against the very approach of temptation in any form, so that we may keep ourselves pure. How very slowly, how very secretly does temptation often make its power known and felt. If we were to foresee the issues in the case of any twenty

men, taken at hazard in the City, who have reached the years of manhood, we would be surprised and shocked by a somewhat definite percentage of sin and ruin; and the whole final difference separating the bad from the good may have been determined by very insignificant causes at the commencement. One said, "Is thy servant a dog, that he should do this thing?" And there are very few who have fallen into gross sins, who if they could have foreseen their after career would not have shrunk back from it and said, "Is thy servant a dog," that he should become so vile and reprobate? But when we once make acquaintance with vice—you know the old lines—

> "Vice is a monster of such hideous mien,
> That to be hated needs but to be seen;
> But seen too oft, familiar with her face,
> We first endure, then pity, then embrace."

We cannot be too absolute in our avoidance of even "the garments spotted by the flesh"—of any contact, to any extent whatever, with any form of evil. And here I would particularly insist upon the necessity of our guarding against making acquaintance, even in books, with histories and haunts of vice. Some of us who are teachers, and occasionally censors of literature, have the misfortune to be obliged to examine such books, and we may do it in such circumstances with a certain measure of safety. But no one, out of curiosity or a prurient desire to become acquainted with evil, can

enter upon such an examination and come out unscathed. And there is no necessity for our making acquaintance with vice in any such forms. We have large enough scope in making acquaintance with virtue; and he who knows virtue can easily, if he choose, imagine for himself its opposite, but he is certainly under no obligation to gain such familiarity with that opposite as would risk personal taint and injury.

Need I say that it is important, in a city like this, that we should be careful of our companionships? I cannot lay too much stress upon this. We are gregarious animals, and I am no apologist for single blessedness. I believe there are advantages in our herding together in flocks. God did not form man to be alone, He designed woman to be his help-meet. It is a good thing when two kindred minds—man and woman—come together, to be mutual helpers, bearers of each other's burdens, and sharers of each other's joys to the end of life. I am no advocate for monkish solitariness, nor do I advise any attempt to escape temptation in that direction. But we must take care that we form no intimacies with any who by their talk will lower our feeling or our thought, and by their conduct will influence us badly or sadly. There is a magnetism that some men and more women have, and that magnetism may be used for good; thank God, it often is used for good. But there is also a magnetism that others have that is often used for evil.

If we come within the sphere of a good man who is possessed of this mysterious power, or, better still, within the sphere of a good woman, it will be a blessing to us all the days of our life; but if we get within the range of an evil man, or, worse still, of an evil woman, it will curse us all the days of our life. So that we cannot be too careful in guarding ourselves against evil influences, and in bringing our minds under good influences. Just in proportion as companionship is agreeable to us will be its power to make or mar us. If we do not care much for anyone, their influence will probably prove trifling; there is danger or benefit in proportion to the extent of our liking or love. Therefore the stronger the attraction, the more carefully we ought to estimate the direction in which it carries us, and to take heed that it be exercised for our well-being, and not for our ill-being. Surely there is no difficulty, especially in such cities as this, and particularly in such associations as this, in our getting right associates, in having as friends those who will help and not hinder us in doing right. "I am companion of all those that love thy precepts," said David; and we cannot take a safer rule to guide us in the formation of friendships than that of which David speaks. A man or woman who fears God will not injure us; and those who have no fear of God in them—I will not detract from any other excellent qualities they may possess, or say that

they are full of malignity and uncleanness—but we have no security in associating with them that our tone—it is not easy to describe the thing, but this word conveys the meaning—that our tone shall not be lowered, and we ourselves really made less able "to deny ungodliness and worldly lusts, and to live soberly, righteously, and godly in this present world," than we would otherwise be.

In approaching the special temptations one has to deal with in life, I am inclined to think that they might all be summed up in one phrase which I mentioned at the outset—*excessive excitement.* We find that sought, first of all, in *drinking;* we find it sought in *licentiousness;* we find it sought frequently nowadays in *gambling;* and, lastly, in certain places of *amusement.* These four forms of excessive excitement, in our time at least, and in our circumstances, meet us on every side; and those who yield themselves freely and carelessly to the influences of this excessive excitement so presented, are what we may fairly call fast men and fast women. The definition that I give of fastness is the unrestrained abandonment of ourselves to the action and influence of this immoderate excitement. "A short life and a merry one," they say. Short enough, but not so merry. It requires no profound investigation to discover that. There is no such thing as true merriment in excessive excitement. There may be &c-

casional lurid flashes of a kind of lunatic gladness, but that is altogether different from the calm content and blessed happiness that flows through the soul when God's laws and limits are observed. Besides, after excessive excitement there always follows a period of depression, which does not follow the calm, equable enjoyment of the pleasure that goodness affords. We can differentiate pretty easily between the evil and the good by this simple fact—the good sustains and nourishes, the evil weakens and depresses. There is always, in consequence of the evil, a lowering of the physical tone—I am not talking of the mind or the heart just now—a feeling of weakness and vapidness from which we have thereafter to recover; but in the enjoyment of what God gives freely, this is altogether absent.

Shall I begin with drinking, which really is in most cases the introduction to all the others? Please to understand that I am not going to make any very strong statement in regard to total abstinence, or any peculiar method whereby we may train ourselves to walk safely in the path of life. I am speaking simply about enjoyment. I leave out of view, therefore, the uses of strong drinks in connection with health, or with certain ailments for which they are supposed to be reliefs if not cures. I have nothing to do at present with those instances in which they may be pleaded for on account of our physical well-being. But when they

are taken for conviviality, and to produce excitement, when they are taken avowedly and deliberately to raise the tone of our feeling and to enable us to enjoy life, as men phrase it, they are evil, and only evil, and that continually. And I defy all the doctors in Christendom to contradict this statement. We might not agree in regard to their action as remedies, but I am quite sure all wise physicians will agree in regard to this particular feature: that when they are taken simply to excite and raise the animal feelings, and at the same time—for this is always an accompaniment—to dull the moral feelings, then they injure us, and can only injure us. And those who are in the habit of using them for this purpose always do suffer, as I have indicated, from consequent depression. When they "make a night of it," in which there is conviviality for, say, four or five hours, they are not in a fit condition for business next day. They do not get natural, healthful sleep, and do not go forth fresh in the morning to do the day's work. If they are their own masters, they do not do their duty to themselves; and if they are the servants of others, they defraud those who have a claim on their labours. There is a great difference between sleep that is healthful and the sleep that is produced by the action of narcotic doses of these drinks. In some cases opportunity has been given for examining the state of the brain during healthy sleep, and it has been found that it becomes

pale; the blood that ordinarily gives it a reddish tinge does not flow through the organism so freely, and because of the diminished flow of blood, the brain is at rest. Consequently it becomes refreshed and recruited because of this inactivity, and is prepared for the resumption of its labours when sleep is over. But when we poison the blood by means of alcohol, then instead of the brain being pale it is flushed with a dark red, sometimes approaching to black-coloured, blood, and the individual, instead of enjoying brain-rest, really has his brain poisoned, and is indeed in a condition perilously approaching apoplectic fulness. It is not healthful sleep that is gained by narcotics, it is not of the same kind and character, and does not refresh and calm the brain in the same way as sleep gained by the natural means that God has appointed for the relief of the brain and its thorough rest and recuperation; and consequently, though there is such a thing as drunken sleep, and very deep sleep it is, it is like what medical men call "coma." From healthful sleep you can rouse up a man. Some cannot be easily awakened even by a loud noise, but ordinarily we can do it by a very little shaking. When a man is stupefied by drink, however, it is very difficult to rouse him. Even if for a moment you may waken him, unless there is strong influence brought to bear upon him, he falls down senseless again. Certainly that is not true sleep. And those who pass into this comatose state do not

go forth from it refreshed, and fitted fairly to do the work of the next day.

Now I am not speaking, as I have said already, in regard to other effects of strong drink, but simply in regard to this fact, that by stimulating or narcotising ourselves after this fashion we are really losing our energy, and unfitting ourselves for resuming our tasks. But then there is this other fact to be kept in mind—and it is a fact that is, to my mind, of extreme importance—that there is no method whereby a man can more easily form a liking that grows into a passion for these strong drinks. There are thousands of people who drink moderately all their days, and do not make themselves sottish as many others do. I have no wish whatever to lessen the weight of that fact in dealing with this important subject. At the same time there is a tendency to form this liking and passion, which is strongest in the finest natures, strongest in those who have the most nervous constitution, and who are often best adapted for accomplishing good work in the world. Consequently, many of our noblest men of genius have become drunkards, not because they were worse than others, but because from their physical temperament they were exposed to dangers that coarse and stupid people escape. And the very fact that all sensitive natures gain this measure of excessive enjoyment, and repeat it time after time, has two effects. In the first

place, it leads them to crave, by the very necessity of their physical constitution, for larger doses, because the smaller dose does not continue to produce the same effect—they must increase the quantity to gain the same result; and secondly—this I must emphasise, because I believe it to be of very great importance indeed—an appetite and desire for these drinks is formed that gains a tremendous power over some of the finest natures that we recognise in this world of ours. And no one knows, except those who have experienced it, or those who have to deal with others who are in the grasp of this enemy, how strong and iron that grasp is. It is not an easy thing for a man who has acquired this lust to resist it. If it has gained an easy victory over him, he will not gain an easy victory over it. It is a hard struggle, come when it may. But I have this to say—in case there may possibly be any one present who has learned to like these drinks—there is nothing at all to make you fearful in entering upon this struggle. I believe any one may throw off this tempter—I say it advisedly—if he just makes up his mind that he will *patiently bear the suffering through which he must pass for a definite period.* I saw an old soldier three days ago who had been converted in India. Previous to that time he had been a notorious drunkard, one of the worst men in the regiment, and frequently punished for his

drunkenness. He had served in the army for a number of years, and was discharged a short time ago without any pension or rank, for promotion had been forfeited by his own folly and sin. When he was converted, one of the first things he resolved was, that he would taste no more drink. "How did you succeed?" I asked. "Oh, very well, sir; I have not tasted drink since." "But didn't you find it hard?" "Yes, I did for a month. When the month was over I found it comparatively easy, and, thank God, I have no appetite for it now." "During that month, when you found yourself tempted, what did you do?" "Well, I just said to God, 'My heavenly Father, you know my weakness, and how I cannot save myself.' I called to Him for help, and so I was able to resist temptation." But he had a struggle. I believe any man who makes up his mind for a few weeks' hard struggle may, in God's good providence, become a fresh and vigorous man again. The difficulty is to get men to summon up courage to bear the pain and hardship needful in order to gain the victory. The drunkard seems, somehow or other, to lose his manhood; he has no backbone, no confidence, no courage. It is a very rare thing to get any one who has lived long in this course to make the resolve really and earnestly that he will throw off the incubus that is crushing him to the earth. He might throw it off if he would; but ah! that *would!*

To bring him to be willing is a very hard task, for the drink saps his manhood, and leaves him feeble and powerless.

Why should any run that risk? That is a very strong plea for total abstinence. There is no necessity for running it. I do not believe there is any, under any circumstances, and certainly not for enjoyment. If we keep our appetite keen, we shall be able to enjoy life fully without any such artificial excitement; we shall be able to enjoy it steadily and right on.

There are others who drink, not because they have any pleasure in it—that has gone long ago—but in order to drown their miserable feelings, and deaden their physical pain; not because it gives them the exuberant gladness it once offered, but because they can forget their sorrow, and remember their misery no more. Their case is pitiable indeed.

I do not intend to say, however, that the man who abstains from drink abstains from other sins. That is not the case. There are people who may be very careful in this matter, and very careless in tampering with sins equally vile. At the same time, those who expose themselves to this evil are more ready to fall under the power of other temptations, and the second sin—licentiousness—is very closely connected with drinking. I have an impression that if we had the histories written of those who have fallen into this sin, and if we had accurately described to us the first

occasion on which it was committed, we should find, in a very large number of cases indeed, that the moral sense was dulled by drinking before they abandoned themselves to the other temptation. It is quite well known that those unfortunates who make licentiousness their trade do find it almost invariably needful to deaden their sensibilities, that they may continue with some measure of resignation to ply their degrading traffic. I believe in most cases, there is at all events in the first instance, a blunting both of consciousness and conscience before there is a bold committal of this sin. I do not mean to say that this does not happen when no strong drink has been taken. I do not make any such foolish and extreme statement. But in many cases the drink sends to sleep the sensitive conscience, so that there is no solemn and startling warning given of the danger, and no clear appreciation of the sin.

Licentiousness is a very great and—one almost fears to say, yet is strongly impelled to say—a growing evil of our times. It has sometimes been said that we have all the natural appetites given to us for use, and that there is no reason why the appetite that leads to licentiousness should not be indulged like the others. But we must remember there is a clear and broad distinction between the appetites. A man may live all his days celibate, and not suffer in the slightest degree in health. There is no necessity for the

action of this appetite. We may maintain the utmost vigour, and engage in all the work that is needful, and reach a ripe old age without the slightest indulgence of this appetite. It is not so with some other appetites. We have many healthful specimens of such people in the world, I believe, among both sexes. Many of them have been angels of light in many homes, such as old maiden aunts and others, who have been centres of blessing to those around them. There is no natural or physical necessity for the indulgence of this appetite. At the same time, there is no reason why it should be so limited as to lead us to the conclusion that it should never be indulged; and God has given us the opportunity freely and fairly for its indulgence within right limits. And I do not think that it is so well for young men or young women, if they can order it otherwise, to live apart, as to live in the married state. I believe that condition is, on the whole, happier; it conduces in many ways to healthfulness, and it is to be chosen rather than the other if it can be so chosen wisely. Only we are not to suppose, as sometimes I fear it is suggested by some physiological books, that we endanger our health if we are continent and self-restrained. No harm can come from continence; but there are a thousand harms from incontinence.

There is also this drawback attendant on the indulgence of this appetite. It is in all cases an

expenditure of energy, and the expenditure is large in proportion to the excitement. It is precisely on this account most wasteful when it is indulged promiscuously. There are hindrances to its undue exercise in the Divine Institution which are not found in connection with the vicious indulgence. There are weaknesses of the body and mind resulting from incontinence, with which medical men are, unhappily, very familiar: it withdraws power from the different functions that might be otherwise needfully used; it is often to be blamed for weakness of the digestive organs; very frequently it is to be blamed for weakness of the judgment and weakness of the brain. It tells very injuriously on the whole frame, and it tells most injuriously on the most vital and important part—the nervous system.

I do not enter into this subject in any detail, because, as you must all feel, it is a delicate subject, and it is not advisable that we should dwell on it at any length.

We know that by licentiousness disease is propagated; disease, the extent and fatality of which none but medical men are able to appreciate. There are a great many cases of disease that appear to have no connection with this sin that are directly traceable to it; disease not in the individual himself only, but in his innocent children: it may be also in his innocent wife. There are diseases that take other forms,

and that we call by other names, and that the ignorant public seldom associate with this evil, that can be directly traced to it by the eye of science. It does immense harm, and I do not wonder that some medical men, in their anxiety to save the innocent, should insist on having an Act to subject all who are the propagators of such diseases to regular examination. I do not agree with them, but at the same time I do not wonder at this anxiety, because kind-hearted physicians feel that it is very hard that those who are innocent should suffer through the sin of another. My reason for differing from them is simply this: that any such measures of repression, besides being unfair—dealing only with one side—besides introducing police espionage in a way that must lead, and has led, to untold moral mischief, even with all the guarantees that the wisest men may give, do not really prevent the spread of contagion. We find contagious diseases of this sort far more widely spread in Paris and Vienna than in London. In spite of all the care that is taken, we find these diseases prevalent in towns where the supposed centres of infection are placed under the most exact, and apparently sanitary, police regulations. And it is not difficult to explain the reason. Our medical friends point to the statistics of disease in the army and navy, to prove that the army and navy have improved in health by means of this supervision.

I am not unwilling to admit the force of these statistics, because those for whom the Acts were passed are confined within certain limits, and if you can secure that their companions in sin are free from disease, you ought to secure to a very remarkable degree a corresponding decrease. But when you attempt to apply it to the whole population, it fails to exert this preventive influence. There are many sensualists who have plenty of money at their command, and who will not consort with those who come under the scope of these Acts. When those with whom they do consort contract contagious diseases, they are very careful to hide it from surgeons or physicians, lest, it being known that they are thus tainted, they should be placed under the same inspection as the others. On that account, and simply speaking in regard to health, I object on hygienic grounds to any such endeavour to limit the outgrowth of this evil. As far as I can trace it, God has placed a signal mark of His displeasure upon this sin, and although we are very anxious to protect the innocent, and would do all we can if possible to prevent the spread of the disease, we are baffled by the perversity of human nature. It is the physician's duty to cure if he can; he does not take direct cognisance of sin. There is a good anecdote told which illustrates this point. At the time of one of the revolutions in Paris a great many wounded men

were carried into the hospitals. One day it was asked of the head physician, "How many rebels have you got in the hospital?" "None, sir," was the answer; "I have only got patients." That was the right answer for a physician to give. It is his duty to help to remove disease as best he may. Yet we find that it is impossible to extirpate this evil by any methods that human wisdom can dictate, for it would seem that God's curse follows the sin, and there is no escape from the lighting of it even upon many who are not guilty.

But there is another evil which I may describe in the words of one of our Scottish poets:

> "I waive the quantum o' the sin
> The hazard o' concealin;
> But oh! it hardens a' within,
> And petrifies the feelin'."

Burns knew what he was talking about. He had sad experience of the mischievousness and folly of this sin; and when he wrote these lines I have no doubt the words flowed from his heart:

> "It hardens a' within,
> And petrifies the feelin."

And it is not good for us to have the freshness of our feelings injured. I am not speaking of this as a moral question, though I could speak strongly if I were dealing with it as a Christian man. I am speak-

ing simply from the platform of physiology. It hardens the nature of a man, and makes him very different from what he might otherwise be. There are none who enjoy the blessings of the marital relationship as those do who have kept themselves absolutely free from this vice. Associated ineradicably and naturally with this sin is a tendency to despise the female character generally; and we cannot suffer more in the best part of our nature than when we lose our reverence and esteem for women. I have no wish to pass any eulogium on the other sex, or to say that they are in all respects equal to or superior to men; but we all know in our heart of hearts that woman has a purifying influence in society, and that anything that leads us to look upon her irreverently, anything that may persuade us to think of her as a slave, or as an instrument of passion, is not merely a wrong done to woman; it is a deadly wrong done to ourselves. For the sake of our own nature that we may keep this helpful reverence sweet and pure, we should avoid the company of degraded and unsexed women as we avoid fire.

I do not dwell on this subject any longer. I have endeavoured to speak plainly, while striving to avoid language which might suggest evil. The subject is a very wide one, and one of very great significance. There are other evils that young men particularly suffer from in consequence of the folly and the wicked-

ness of their companions in earlier days. There is one advice I always give to young men in such circumstances, and which I think contains the essence of all the advice that could be given. It is this: Strive to improve your general health and your moral health as much as possible. Avoid painstakingly every incitement to evil. Weary yourself as often as you can by hard work, so as to ensure good appetite, and so as to make thorough full sleep a necessity. By acting on these principles we may wither and destroy those fruits of our own early folly. Never, in any circumstances, have recourse to any of those quacks who advertise themselves as able to cure men of the consequences of these vices. Go to a Christian physician. And you need not go with any peculiar shamefacedness, for I am sorry to say the evil is so common that no Christian physician will be astonished at your seeking his advice. He will give you hearty sympathy, and treat you with all tenderness, if it is your desire, as I believe it is the desire of those who know their danger and who know their duty, to escape from the snare and to live better and more wholesome lives.

Gambling, I am sorry to say, is one of the excitements of the present day. I am astonished, startled, and surprised to find, when travelling by rail, so many reading the sporting papers. This desire for speculation seems to have spread itself throughout society. Some will tell us it has its head-quarters in a certain

part of London, where speculation is very much of the same character as gambling on the turf or in private rooms. I am not dealing with the morality of it, but speaking only as a physician, I say that all excitement of that kind is one of the surest producers of worry. And worry is a bad thing, as you have learned already. Any such excitement and tremulousness in regard to consequences tell upon the nervous system, and make us more susceptible to evil influences. It weakens the physical nature, and will act, I believe, upon the moral nature, whereas wholesome work braces and strengthens us. Shun all such excitements sedulously, if you desire to live a long, a healthy, and a happy life.

Permit me to say a few words in regard to common amusements. I cannot speak about theatres, because I have never been inside a London theatre or music-hall in my life. I do not mean to say I have never been inside a theatre, but I have never been in a London theatre or a London music-hall; consequently I cannot speak particularly or with any accuracy in regard to amusements in this city. But as far as I can learn from a pretty careful reading of the newspapers, and from general sources of information accessible to me, I should suppose these places are not wholesome. I do not need to raise the question whether it is right or not to have dramatic representations. That is a fair question for debate; but to attend such dramatic representations as are given to us, and under the cir-

cumstances with which we are familiar, I think is not safe or wise for those who have much work to do. It will not brace them up, or fit them for doing their work. Instead of strengthening them, or making them better able to bear the burden of life, it will weaken them, and make them less able to carry it. I am not dealing with the morality or immorality of theatres.

As to music-halls, I can judge from the specimens of songs that come under my notice. I do not understand how people can find enjoyment or amusement in them. Their wit consists of silliness; and while sometimes one may be inclined to laugh at a silly thing, to go on laughing at them night after night, and the whole night through, seems impossible to sober men. I have no objection to a hearty laugh at true wit. I enjoy fully such sparkling wit as we get from the philosopher of Fleet Street. There is salt in it. I do not always agree with Mr. Punch. He makes sport of total abstinence sometimes, and I do not think he is always correct in his views of Evangelical Christianity; but he is almost invariably on the side of truth and righteousness. And I think it is one of the happy signs of the times that our leading comic paper is on the whole so healthful. You will never find in it matter that will cause the innocent maiden to blush; and that cannot be said of the leading jesters in other countries of the world. Wit, if wholesome, is good; and laughter expands the lungs, strengthens the

muscles, and helps digestion. "Laugh and grow fat" is an old and a very good adage. I have not the slightest objection to real merriment, but it must be real. The point of many of these music-hall songs seems to consist either in their silliness or their indecency. I need not say that the ability to enjoy such songs does not strengthen us in any way, and the nature of the excitement to be found in such places will tell injuriously, I believe, upon the physical frame.

Horace Mann tells us, in a very pithy lecture styled *Thoughts for Young Men*, that in the old time knights-errant used to defend innocent men and chaste women from the oppressors; but in our time the true knight-errant will defend the innocent man and chaste woman from himself. To keep ourselves pure is the great duty that rests on each one in the present day. Not merely to see that others do not do wrong, but that we ourselves do not do wrong. And, to some extent, we do that best by maintaining, on the lines I have indicated, a sound mind in a healthy body.

VI.

A MERRY HEART.

I PRESUME you are familiar with the words from which the title of the present lecture has been taken: "A merry heart doeth good like a medicine." (Prov. xvii. 22.) Cheerfulness and contentment are not only elements in happiness; they are also excellent specifics for the preservation of health. Gloom and moroseness deteriorate life, and lessen our power of resisting disease. We are all familiar with the fact that fear often determines the action of contagion, and that a brave man who, in the performance of his duty, goes readily wherever sickness is found, generally comes scathless through the trial, whereas a timid man, who dreads the danger, is almost sure to be stricken down. In a very interesting discussion on the causes of the deterioration of individual and national vitality, a scientific physician places high in rank the passions.[1] And among these he enumerates four as occupying the first place—anger, hatred, grief, and fear. I am not quite sure that we have ever

[1] Richardson's *Ministry of Health*, p. 80.

apprehended fully the nature of the action of these emotional causes upon the physical structure. But that they do act very decidedly is beyond question. We find, for instance, that fear blanches the cheek, and oftentimes sends a tremor through the limbs. This feeling has affected the little capillaries, or vessels that convey the blood into the cheek, and it has also somehow acted on the muscular system so as to produce the trembling.

There are cases on record in which, through fear or anguish, the hair has turned grey in a single night. And in the presence of this fact no one can deny that emotion has a wonderful effect upon the physical organism. Moreover, it can affect us healthfully no less than harmfully. It can help and strengthen us if it be of a favourable kind, just as it weakens and injures if it be of an unfavourable kind. Indeed, the influence of the mind upon the body (to which I called your attention on a previous occasion) is found to be of extensive application in regard to health, and in regard also to the treatment of disease. By fixing our attention on any part of the body, in favourable circumstances, we can influence the action of that part of the body to some appreciable extent. There is a very curious case narrated by Dr. Braid, of Manchester, in which he asked four distinguished gentlemen to place their arms on a table with the palm of the hand upwards. At the end of five minutes each

had a different experience. One of them found his arm getting cold; another found his arm and hand getting hot; another thought that there were electric shocks passing through the arm to the table, the other found that his hand became fixed to the table, so that he could not raise it up. All these strange results were produced simply by their attention being called definitely to the arm and the hand for the period of five minutes. Any one who continually dwells upon the action of any part of his organism, especially if apprehending mischievous results, is likely to produce an abnormal condition in that part. Hypochondria, a condition in which people imagine all sorts of things without sufficient reason, very often ends in real organic mischief. When our attention is called to any part of the bodily framework, and we apprehend that there is mischief being done there, the very direction of the attention often produces evil results. And, on the other hand, if we are hopeful and expecting a good issue, the very hope that we entertain suffices frequently to bring about the cure that we desire. There are many instances on record in which very strange results have been produced by means that seemed not at all calculated to produce any definite result whatever. In the life of Sir Humphrey Davy we read that when he and Dr. Beddoes were experimenting with nitrous oxide, it was conjectured by Dr. Beddoes that it might

prove helpful in cases of paralysis. A gentleman who suffered from this disease consented to be operated upon. Dr. Beddoes had spoken to him beforehand, and had expressed his strong conviction that by the novel treatment he would be greatly relieved. Sir Humphrey Davy, before proceeding to administer the gas, in order to ascertain the temperature of the patient's body, placed a thermometer under the patient's tongue. He immediately exclaimed that he felt the symptoms greatly alleviated. Sir Humphrey Davy took the hint and dismissed him, telling him to call upon him next day. He did so, and again the thermometer was placed under his tongue as before. The patient was relieved to a very considerable extent in the course of a fortnight! The expectation of cure wrought upon him so thoroughly that it produced quite as definite results, probably, as the administration of the gas would have done.

Dr. John Brown[1] tells us of a simple-minded patient who complained of severe internal pains. The doctor wrote out a prescription, and handed it to him, saying, "Take that, and you will be well in a fortnight." He came back at the end of the time looking very healthy and strong—in fact, quite recovered. The doctor was very proud of the thoroughness of the cure, but he had forgotten what particular remedy he had prescribed. So he said, "You have

[1] *Horæ Subsecivæ.*

got well?" "Oh, yes; perfectly well. I never felt better in my life." "Show me the medicine you took." "Oh, I took it." "But I mean the prescription." "Why, I swallowed the prescription; that is what you told me to do!" By means of the prescription, taken in this novel fashion, he was effectually cured of the disease.

Now do not suppose that these are merely casual illustrations. There are hundreds of cases of a similar kind, well known to medical men, in which hopefulness and expectation of cure have wrought remedially in the human body. The *expectation* of good results from something prescribed has been sufficient to banish the malady and restore health. On the other hand, there are many cases, well known also, in which fear and the apprehension of evil have resulted in very serious mischief. There is a story told of a farmer—I think you will find it put into rhyme by Wordsworth—who, having had his wood stolen, went one cold winter's night, when the moon was shining, and concealed himself behind a hedge in order to discover the thief. He lay there for a long time, and was chilled, as we say, to the bone. At length he saw an old woman coming cautiously along. When she had gathered a sufficient quantity of sticks to carry away, he emerged from his concealment, and laid hold of her, using very strong language indeed. She raised her hands in the moonlight, and said,

"May you never know what it is to be warm from this time henceforth!" The poor man, who was shivering already, shivered still more when he heard these words. He actually went home and lay in his bed for about twenty years, no amount of covering being sufficient to give him satisfactory warmth, until he died. A great many cases of so-called "witchcraft" are explainable after this fashion. The conviction that we are to suffer in a particular manner may produce and perpetuate the suffering, just as the expectation of good may determine an opposite result. I have been told by a friend who was in India that sometimes when they suspected theft in the old days, they used a very simple method of discovery. They gathered all the natives who were supposed to be implicated, placing them in a row. After certain preliminaries, a ball, supposed to be specially prepared, was thrown into the air, the natives being told at the same time that it would fall on the thief, and so detect him. The thief was always sure to look up to see if the ball was coming, and thus he was easily discovered.

The power of the mind over the body in such circumstances is exceedingly strong. Of course as we get wiser and more intelligent we are not so likely to be influenced by these ideas, or to harbour any such thoughts. We banish them, and consequently they do not affect us in the same way as they might other-

wise have done. We find that we can free our minds from unpleasant or undesirable thoughts. And I believe that it is in this direction that we get most helpful hints in dealing with the special subject I am now bringing before your attention. We may learn to cultivate habits that will secure us against unpleasant thought and emotion, and that will make it easier to indulge healthful thought and emotion. In this way we can escape mischief on the one side, and secure good on the other.

I do not think I need talk at greater length in regard to this fact. You will find a great many illustrations, if you wish to pursue the subject, in a very interesting book by Dr. Tuke on *The Influence of the Mind over the Body.* Dr. Carpenter, in his *Mental Physiology*, has also pursued the subject at some length. Indeed, there is no lack of materials to give us full information in regard to this strange influence that is exerted by the mind over the body.

Now to return. Cheerfulness, contentment, our being able to look at the bright side of things, our dealing with events in a happy spirit, may not produce any one marked effect, but it seems to aid in carrying on all the functions of the body in a pleasant and healthful manner. Those who are tormented by envy or jealousy, or who cherish feelings of revenge, are not only disliked by others, and dangerous to others; they are also really injuring themselves. These passions

or feelings act injuriously upon the whole system, and it is for our own interest and well-being that we carefully eschew the indulgence of such passions. I dare say many of you are familiar with a very excellent illustration of the cultivation of cheerfulness, though somewhat exaggerated, in the character of Mark Tapley. He was beloved by all the children in the village, and hailed with rapture by all his friends. He thought it no credit to be jolly under such favourable circumstances. Therefore he went to America along with his friend Martin Chuzzlewit; and you remember how jolly he contrived to be when attending to the sick women and children on board, in the steerage of the vessel, and afterwards when he was struck down with fever while attending to his friend who was suffering from the same disease, in the dismal swamp to which they had gone in the hope of finding it the site of a large and flourishing city. Mark Tapley cultivated this quality of being jolly in unfavourable circumstances. And there can be no doubt that we have it in our power to cultivate this quality to a very large extent indeed. I do not forget that there are conditions of the body in which fretfulness or irritableness are natural. In weakness and in pain it is very hard to be merry. Diseases, of certain kinds particularly, produce a state of mind the very opposite of cheerfulness, and it is not easy for those who thus suffer to maintain an equable and

pleasant disposition. But who has not known some of these sufferers, who are no less distinguished for their patience than for their pains, and who from their sick beds have given us distinguished examples of willingness to bear affliction, and who have counted its discipline among the most precious gifts attainable in this world? From the darkness by which many of them are surrounded, they shine out all the brighter, just as the lighthouse shines most clearly as the night falls. We have it in our power—and this is the practical lesson I wish you to learn—under the most unfavourable circumstances, and when we are suffering even keenly, to cultivate cheerfulness of disposition, and it is for our benefit and advantage that we should do so.

Addison, in one of his interesting essays, tells us that there are three lights in which we can regard this virtue: first, in regard to ourselves; secondly, in regard to our neighbours; and thirdly, in regard to God. As bearing upon ourselves, it gives us sobriety of judgment, and enables us to act calmly and wisely in all circumstances. As regards our neighbours, it enables us to diffuse a cheerful atmosphere wherever we go; it allays, to some extent, their irritations, and is a source of blessing wherever we carry it. In regard to God, it is a grateful hymn of praise to Him, and indicates our acquiescence in His will, and enables us to bear all things patiently for His glory. I cannot

exaggerate the value of cheerfulness, either in regard to the happiness that we naturally seek, or in regard to the healthfulness and well-being of the body, with which we are specially dealing in these lectures. Fretfulness and all passions of that kind wear and waste the very substance of the body. They give the man a lean, anxious look, and often derange the digestive functions. They alter not merely the fluids, but, to some extent, even the solids of the body. I believe that almost all these passions spring from selfishness, operated on by different causes, and acting in different directions. A man will throw himself down hopelessly on the ground, and complain that the fates are against him, that others succeed, but he fails. He looks at those who started with him in life, having precisely the same advantages and the same disadvantages, and he grumbles because they have gained the top of the ladder while he is lying down at the very foot. He thinks their lot in life has been a lucky or fortunate one, whereas his has been altogether of a different order. It would be well for us to remember that, whatever be our position, we have succeeded beyond our deserts; we must be convinced of this if we estimate carefully our own unfitness for all that we have gained, and our own inadequacy to the tasks that we are endeavouring to discharge. I believe it is both safe and wise for us, when we do gain any of the results that we have laboured for, to understand

and believe that these are more than our capacities or our labours have entitled us to.

On the other hand, when we do not succeed, when we fail in this direction or in that, and when it would seem that adverse circumstances conspire, in some measure to prevent our getting on, it is well to take to ourselves this thought—that we really do, according to our energy and skill, gain as much as that energy and skill were entitled to gain; and that whatever we have not gained might have come to us, perhaps, by more fortunate circumstances, but that at least we have had as much as our energy and character have deserved. And especially if we are acquainted in some measure with our own hearts, we must feel that all our failures and shortcomings are traceable to our own weakness and wickedness, and that God doth not afflict us even to the extent of our deservings. When we look at the matter in this light, and consider that there are many things given to us for which we have no claim, we shall at least be induced to look abroad with a calmer mind, and, mayhap—and this is the important thing—to rise from the ground in a more hopeful spirit, and determine that we will, through the grace of the Lord Jesus, be truer, wiser, and better in the future than we have been in the past. The man who simply lays himself down to fret, and pine, and complain, only hinders himself from the possibility of retrieving his misfortunes or gaining any good; whereas, if, in the

spirit of conscious weakness and ill-desert, he yet determines that he will put forth all his energy, in dependence on the grace of God, even though he may not gain all he seeks, he will gain the strength that comes from prayer, and will learn that discipline, if it does not always end in victory, at all events nerves the hand and encourages the heart.

Cheerfulness in all circumstances ought to be carefully cultivated. It is from our own innate selfishness that the opposite feelings—I do not enlarge on them—always spring. For instance, to return to Dickens's story, we find there other two characters besides Mark Tapley—Martin Chuzzlewit and Tom Pinch. A noble fellow Tom was. He could even believe in the hypocritical Pecksniff. It was very hard to convince him that the man was a scoundrel. I honour him because of his faith in Pecksniff. He was so good himself he could scarcely believe such wickedness could be found in another; whereas Chuzzlewit, an intensely selfish fellow himself, saw through Pecksniff's selfishness and hypocrisy at once. It is a great thing not to be able to see selfishness in other people. Our ignorance is not likely to do them any harm, and it may do them some good. It will be a great gain to ourselves if we are able to take a rose-coloured view of things throughout all our course in life. Unfortunately, there are few of us so genuinely innocent as Tom Pinch. We are sharp enough—I do not know that our acuteness is much

to be envied—we have sufficient acquaintance with evil in ourselves to be able to detect evil very readily in others. We have the fatal knowledge of good and evil. Tom is represented as being destitute of the knowledge of evil, but we have a pretty large share of that particular kind of information. I wish to insist on this—it is very important, and I do not think that I can put it too emphatically—that we cannot safely be like God in knowing good and evil, unless we seek to be like Him in holiness of life. We cannot safely come into contact with evil unless we love the world in the same way as God does, who gave His Only-Begotten Son in order that He might save the world from its vileness. Love to the sinner and the desire to deliver him from the evil is our only protection in this knowledge of evil. Depend upon it, those who look into the depths of wickedness and make a study of human malignity, seeking to anatomise it and understand all its different branchings, and who are obliged to familiarise themselves to some extent with its widespreadness and its intenseness, need to have this love that seeks to save the vile, and longs, with a God-like yearning, to do something for the removal of sin.

We all have to come in contact with many things that will try us, and with many things that will irritate us, and it is very hard to maintain a cheerful disposition under these circumstances. But it is no credit being jolly in favourable circumstances, and if we

are to be cheerful in the time of darkness and affliction, when we are sore beset by temptations to moroseness and repining, we require strength of character and strength of mind to resist these temptations. A man, I confess, *may* get a great deal of that strength by making and fulfilling the resolve that he will do everything in his power to maintain it and increase it. And we can do a great deal by withdrawing our attention from those things that give us pain. You have seen a nurse trying to quiet a child. If she is a wise nurse, you find she produces a loud and unexpected noise, and the child stops crying as if by magic. Its attention is arrested by the noise, and it begins to wonder about that, and forgets to think of the pain. By-and-by, when the noise becomes familiar, the nurse adopts some other method to withdraw the child's attention from its annoyance, and so tides over the fretfulness until the annoyance itself has ceased. We can learn a lesson from this that is of real practical use. If we want to get rid of painful irritation and of the cause of the irritation, we can do it by withdrawing our attention from the painful influence and fastening it upon something pleasant, or at all events different and distracting, whereby our thoughts and actions shall be, at least temporarily, fully occupied. There are some who carry this to a very remarkable degree, and who are able in this way to escape from the evils that they encounter, and to maintain an equable and unim-

passioned frame of mind throughout their whole career. Others dull themselves and make themselves pachydermatous—thick-skinned—so that they do not feel any of the slight inconveniences which make up a great many of the real pains of life. Some one has sarcastically said that life would be bearable if it were not for its pleasures. So we might say life would be bearable if it were not for its little pains, its little irritations and mischiefs that keep our minds fretting and do us harm physically as well as morally. And some have found it to their advantage to cultivate this thick-skinnedness, a condition of indifference and utter carelessness to what may befall them, so that they would scarcely weep if their dearest were suddenly struck down. I do not advise the cultivation of any such condition. We cannot have too much sensitiveness in this world, if it be rightly directed and used. But, on the other hand, the power of withdrawing our attention from things disagreeable or hurtful, and fixing it upon things useful, or at all events harmless, is a valuable faculty that may be, and ought to be, sedulously developed and sustained.

There is, however, another method grander and nobler; a method that will strengthen us, both in body and mind, a great deal more than this simple withdrawal of our attention from things that are painful or unpleasant. We may recognise and recollect always that we are here in training for a higher and fuller life,

and that God, by means of trials and sorrows, is putting us to the proof, giving us occasions and opportunities for becoming more true to Him, and more earnest in doing His will. And nothing will help us more in maintaining a cheerful disposition than the knowledge that we thereby become like unto Him who not only pleased not Himself, but was meek and lowly in heart, who was "led as a lamb to the slaughter, and as a sheep before her shearers is dumb, so he opened not his mouth." If we thus become epistles of Christ, true representations of His character in contentment and cheerfulness of disposition, this will react with intense power upon the health of the body, and will cause all its functions to be carried on pleasantly and well. We shall be fitted not merely for the enjoyment of the blessings that come to us in God's good providence, but for nobler, fuller service even, throughout our sojourn in this world.

Besides, I would recommend cheerfulness—not extravagant mirth, but genialness of disposition, sunshininess of countenance flowing from light in the soul—I would recommend this as one of the best methods we can employ, not merely for our own physical good, but for the good of our neighbours and the glory of God. When we have an Exhibition, the finest productions of art and trade and science are brought together into one building, and they are shown for the encouragement and emulation of others. We,

would never think of gathering our worst productions into a place where we desire to stir up those round about us to admiration of what we have reached and the attempt, if possible, to reach the same perfection. But it seems to me that many Christian people have the idea that the best thing they can do is to groan in concert over their failings, and to condole with each other gloomily over their defects and defeats. How much better it is to bring together all the contentedness and joy that God has wrought in us, and so, without lessening our humility, illustrate the glory of Him who hath "called us out of darkness into his marvellous light." You remember how Titus was exhorted by the Apostle Paul to instruct slaves not to purloin, and not to answer back, but to show all fidelity, that they might *adorn* the doctrine of God their Saviour in all things. By such simple graces, by bearing all things, by enduring all things for the gospel's sake and with cheerfulness, we may be blessings to others, and loyal witnesses to Him who "hath not appointed us to wrath, but to obtain salvation by our Lord Jesus Christ, who died for us, that whether we wake or sleep we should live together with him. Wherefore comfort yourselves together, and edify one another." [1]

[1] Thess. v. 9-11.

VII.

DISEASE GERMS.

AS having a very intimate connection with our present subject, I may remind you of the old adage, "Prevention is better than cure." Many years ago, Dr. Guthrie, in his *Plea for Ragged Schools*, pointed out that a very large proportion of our criminal population formed a natural development of the neglected materials that were to be found abundantly existing in our large towns. He showed by statistics that the cost of prosecuting and punishing criminals was much more than the cost would be of *preventing* young boys and girls from ultimately swelling the ranks of that class. Mr. Plimsoll, in his survey of the dangers of the deep, found that a very large number of shipwrecks resulted from sending unworthy ships to sea, and from sending ships improperly laden. He persistently persevered in calling attention to the subject within the British Parliament, in order that a wise law might be framed to *prevent* such foolish and criminal conduct.

Our sanitary reformers, in like manner, have called

attention to the very large number of what they term (rightly and fairly) preventible diseases, which cause a large proportion of our yearly deaths, and they insist that due steps should be taken to prevent the spread of these diseases. In a Parliamentary return, moved for by Mr. W. H. Smith some time ago, we were told that the annual mortality was somewhere about 500,000, and of that number 111,000 deaths resulted from what are called zymotic diseases—diseases that to a large extent might be prevented. That is to say, one-fifth of the mortality in England is fairly within the reach of science and skill, and might, if not altogether prevented, be at least greatly lessened.

Prevention *is* better than cure, for two very plain reasons. In the first place, if disease once begins, there must be suffering, and loss, and pain to the individual, and the loss for a time of his power of working for his own good and for the well-being of the community. And, secondly, we are not always able to cure diseases. When, in some cases, they are fairly developed, they pass beyond the range of all medical appliances. Sanitarians, however, assure us that it is possible absolutely to prevent a large number of these diseases from originating and spreading within our bounds.

We know that a great many diseases are produced by causes that are beyond our control. We cannot alter the temperature. We cannot preserve ourselves

entirely from the action of sudden changes of temperature. And, as I had occasion to note in a former lecture, there are hereditary tendencies to disease within us—seeds or germs of disease existing in us from the beginning, that in due time may be developed, and that may produce consequent mischief. But there are other diseases—a very large class indeed—that spring directly from poisonous material communicated to the living body. The commonly received opinion nowadays is that a great many diseases of the zymotic class spring directly from what are called "disease germs," and that just as surely as we get animals and plants from their appropriate seeds, so surely are diseases the result of the planting and developing of certain seeds within the human organism.

I have used a term that I ought to explain. I have spoken of zymotic diseases. This word is derived from the Greek *zume*, which means "ferment," and the theory that has given origin to the term is that these diseases are produced in the body very much after the same manner as that in which a ferment acts when it is in contact with suitable liquid. Many of you are aware that it is by means of the yeast plant that we have fermentation produced in certain liquids containing a large amount of sugar. That plant, known as *Torula cerevisiæ*, spreads and multiplies itself with great rapidity in favourable circumstances, and in

the process of growth it changes the sugar into carbonic acid, alcohol, glycerine, and succinic acid. In like manner it has been suggested that disease germs communicated to the human body produce actions of a similar kind, not precisely in the same way, but actions of a similar character, that are manifested in the febrile symptoms and the disorganisation that ensue.

It is not my purpose to expound or defend what is called the germ theory of disease. Although it is so largely received, it is not to be assumed that it has yet been demonstrated. This theory originated naturally enough some years ago, when it was found that a great many organic particles float in the atmosphere, and are mixed up with the dust that is so plentifully present everywhere. Physicians had noted that certain diseases of the zymotic or ferment-like class ran a definite course. They noticed also that there was a period which they called the period of incubation, in which apparently the disease seemed to be preparing for attack. They noticed further that in certain instances the disease was attended by a very large increase of the morbid material from which it was supposed to take its origin. For instance, a little particle of small-pox material—a microscopic particle—is sufficient, if introduced into the body under certain favourable conditions, so to cover the whole body with small-pox pustules, that you could hardly

lay a pin's point on any part free from them. This small particle, on its introduction into the body, multiplies and grows to such an extent that it covers the whole surface with a similar material. From these observations physicians were inclined to infer that there must be something in the elements causing these diseases, similar to the seeds of plants, or the ova of animals. It has been demonstrated by the microscope that there are living organisms capable of giving rise to certain forms of disease. In making this statement I do not mean to say that the microscope has enabled us to distinguish between different kinds of disease germs. We cannot distinguish, for instance, between the germ of small-pox and the germ of typhoid fever, or between the germ of measles and the germ of scarlatina. We are not able to mark out and describe particularly germs as associated with definite diseases. But then you must remember that, as we have already found, we are not able to distinguish by the microscope the bioplasts in the living frame that form nerve from those that form muscle, or from those that form brain. These bioplasts are in all cases structureless, gelatinous material having the power of motion, and yet while they are precisely alike, so far as their chemical and their microscopic character can be ascertained, in one case the bioplast forms one kind of tissue, and in another case an exactly and precisely similar

bioplast forms another kind of tissue. So that the fact of our not being able to distinguish the different disease poisons or disease germs from each other does not prove that each has not its own specific character, and is not to be taken in any sense as an argument against their agency in the production of disease. Over against their microscopical and chemical likeness, we have to set the fact that each one is apparently capable of giving rise to all the phenomena connected with its own specific malady.

Diseases of this zymotic class may be broadly divided into epidemic, endemic, and infectious. Epidemic diseases are those that attack large numbers of people in one country or in many countries, at a particular time or in particular successions of time, diseases that fall, as it were, upon the people (*epi*, upon; *demos*, the people), that attack large numbers of the community, that are transportable from one place to another, and from one person to another, apparently in some line of direct communication. I am not aware that it is denied by any competent authority that there is, in these cases, a specific material, or substance of some kind or other, that gives rise to each of these particular diseases. We can trace the footsteps of epidemic diseases just as surely as we can trace the footsteps of a traveller, and we have been able to ascertain to a large extent the laws on which their transmission and operation depend. And thus, though we may not accept

the theory that they have origin in germs, there can be no doubt whatever that they are communicable to large numbers of persons directly in the form of a specific material cause. We have had in former times such epidemics as the black death, the plague, the sweating sickness; and in our own day we have had epidemics of cholera, typhus fever, scarlatina, measles, &c.; and we have had also within recent times in certain countries epidemics of small-pox. With reference to this last disease, that has often appeared as an epidemic, I wish to say that since the discovery of vaccination, and the application of this process for the protection of the community, whatever theory we may adopt to explain the fact, there can be no doubt it has ceased to be the scourge it was in former days. Whether we accept the theory that vaccination prevents it or not, certainly the fact is undoubted that small-pox does not destroy the large numbers that it formerly destroyed, and it is not now regarded with the same fear and horror that it was in other times. If you consult Macaulay's History, you will find that at no very distant date it was regarded with the greatest apprehension and alarm. Now, although we have not entirely obliterated the small-pox poison, or succeeded in preventing its action —no means have been adequate to its entire extinction —certainly the disease has been greatly lessened in gravity, and it does not now cause the same amount of disfiguration and death that it once caused among

our ancestors. Of course our friends who advocate vaccination—and I thoroughly agree with them—maintain that this change has been wrought by the sagacity of the immortal Jenner, and that by the means of safeguarding the body against the attack of this disease which he discovered and demonstrated, we are able now either to prevent the appearance of this disease, or at least to mitigate its ravages. And it would be a very great scientific triumph, no one can doubt, if it should become possible, after the same fashion, to deal with other diseases of an equally destructive character. Some of our friends hint, and hint with some confidence, that it may be possible for us, in the near future, to deal similarly, and no less effectively, with certain diseases that we now regard as exceedingly destructive, and altogether beyond the range of medical art.

In former years the destruction caused by epidemics was something of which we can scarcely form a conception. One that visited Italy destroyed three-fourths of the whole population. The same epidemic killed 50,000 in Paris, and 100,000 in London. It was estimated that in the course of its progress one-fourth of the population of Europe was swept away.[1] But even from such figures as these we do not realise the full power for evil that an epidemic exercises, for we

[1] Full information on this subject may be found in Hecker's *Epidemics of the Middle Ages.*

have to take into account, besides, the large number who are maimed and made unfit for healthy life ever after. Many of those who are weakened by the attack are also afterwards exposed to other diseases, that by and-by bring them to the grave, or, it may be, render them still more unfit for fairly carrying on the business of life. But we can understand, without any difficulty, that if it be in our power to prevent the spread of such epidemics, to limit their range, or, better still, to extinguish them altogether, a very great result would be gained, both in wealth and in health and in comfort all over the world. And it is to this that our sanitary reformers are specially directing their attention. I speak of this that I may engage your interest in their work, and that I may enlist your sympathy in their behalf. Oftentimes their task is a very hard and thankless one. They interfere with vested interests, and when they touch these interests there is a loud outcry raised against their measures and their operations. Of all the nerves in the body, there is not one more sensitive than that which connects the brain with the purse. When people have that nerve touched they are exceedingly apt to cry out very bitterly. Therefore we need to have an intelligent apprehension that our sanitary reformers are aiming at the well-being of the community, and are seeking—certainly not for their own pecuniary advantage, for that advantage is determined by the number of their patients—to raise

the vitality and health-tone of the nation; and consequently, such well-advised measures as they may recommend, even though in some cases they may be at first costly, must prove in the end no less economical than useful.

There are other diseases that are endemic, such as ague, which formerly prevailed to a very large extent in the fen country. It has now been almost entirely banished from many districts in England in which it was formerly rife. By draining the marshes, and by making the soil assume a different character, this disease, which was extremely common, has become somewhat rare.

Then there are such diseases as goitre endemic[1] in the valleys of Savoy, and associated with what is called cretinism. There are also diseases partly epidemic and partly endemic, like yellow fever and cholera. Cholera originates from and inhabits the delta of the Ganges, and yellow fever is peculiar to certain equatorial regions of America. In connection with this latter disease there are two facts of some interest. We were threatened, as some thought, with a visit of it to this country some months ago, and it might be wise to consider the best defences against its possible approach. Secondly, negroes and Chinamen exhibit a very strange and almost complete immunity from the attacks of this disease. While it is

[1] *En*, among; *demos*, people—among the people.

prostrating other races inhabiting the country to which it is indigenous, it seems to pass by the negro and John Chinaman almost entirely. There are national peculiarities which are worth being inquired into, the knowledge of which might be helpful in our endeavours to extirpate such diseases as these. Cholera has threatened our country, and not only threatened, but visited it several times within the memory of most of us. It has not been feared of late so intensely as it was some fifty years ago. I think it was in 1832 that it visited this country for the first time. I have a distinct recollection of hearing from my own ancestors (not very distant ones) of the awful alarm and the strange superstitions in connection with that visitation of cholera. Then, as in most similar instances in the dark ages—showing that the present age has a little of the darkness left—the doctors were accused of causing it. The wells were supposed to be poisoned, and means and methods were imagined to have been used for the production of this disease that had nothing more to do with it than the moon has to do with the direct production of madness.

Means may be taken, as you can readily conceive, both to allay alarm, and in doing so to prevent, to some extent at least, the ravages of the disease, and also to lessen the fatality of it in case it should make an incursion into any particular district. When the last visitation of cholera was experienced in this city

(London) some thoughtful men in Glasgow took counsel together as to the best means for securing themselves against its approach. The Officer of Health, Dr. William Gairdner, Professor of Practice of Medicine in the University of Glasgow, in conjunction with some others, originated and carried out very extensive and effective preventive measures. I do not think that these measures ever became so widely known as they deserved to be, and I therefore speak of them on this occasion that some at least may be made acquainted with their nature and value. Dr. Gairdner called together all the ministers of the different churches in the city of Glasgow. At these meetings—for several meetings were held—there assembled, in the presence of a common danger, Episcopalians, Presbyterians, Congregationalists, Baptists, Methodists, and even Roman Catholic priests. At these emphatically representative gatherings it was agreed that we (I was then resident in Glasgow) should enlist volunteers from all our different congregations; that the city should be mapped out into numerous districts, one of these districts being allocated to each congregation; and that the enlisted volunteers should take charge of subdivisions in each district, their duty being to visit every house and every court regularly, and to see that no nuisance of any kind was allowed to accumulate, that all the sanitary laws were fairly observed, and to report at

once to head-quarters any case in which there was the slightest semblance of the disease. This arrangement was fully carried out. Volunteers were found readily enough in all our congregations, and for some weeks, I believe, there was not a single house in the city that was not under supervision. Every part of it was thoroughly inspected, and one or two cases of an aggravated form of diarrhœa that occurred were at once reported to the proper parties. We escaped "scot-free" during that visitation of cholera; there was not, if my memory serves me rightly, a single case in Glasgow, though the visitation was a somewhat severe one elsewhere.

I believe that on these lines a great deal might be done still to secure ourselves against the inroads of epidemic disease; and much help given to our sanitary authorities in dealing effectually with any such injurious causes that may at any time be in operation.

It is not so easy to deal with what are called infectious[1] diseases—diseases in which the poison is immediately communicated apparently from one individual to another; communicated, it may be, by the breath, or it may be in water or in food, given off from the person who is suffering and received into the body of an apparently healthy person. I say an *apparently* healthy individual, for I do not believe

[1] It is not maintained that epidemic diseases are not infectious; nor do I forget that infectious diseases may become epidemic.

that an absolutely healthy individual is likely—I will not use a stronger word—to be attacked either by an epidemic or an infectious disease. I believe that in all cases in which these poisons from a diseased person operate upon others there is a preparedness or fitness on the part of the person so attacked to receive the disease material. As I said in my first course of lectures, you require a predisposing as well as an exciting cause.[1] The exciting cause, in the case of those diseases that are infectious or epidemic, whether it be a germ or simply a particle conveying the mischief, requires to find in the individual a certain soil adapted to its wants, a certain fitness for its lodgment and subsequent development. It is quite well known that some individuals may be exposed to a great many such diseases without any harmful result. I do not think we have a sufficient explanation of that —though it has been given—in the fact that a great many men may be exposed on the field of battle, but only a certain number are wounded or killed, and that of all the bullets that are discharged in any single conflict, only a small number lodge themselves in human bodies. A great many bullets fall aimlessly upon the ground. So it is supposed that, though there are a great many germs of disease or disease particles being thrown off by infected patients, yet a large number never find entrance into human beings,

[1] *Studies in Life*, p. 153.

and consequently do not produce any evil result. Thus it is argued that an individual may go into a room in which there are a great many of these particles floating about, as a soldier may go into battle where a great many balls are flying, and come out of the room safe, because not one of these particles has happened to find an entrance. But if an individual abides in that room from morning to night, and from one day to another, and one week to another, I should say the probabilities are very great indeed that he shall receive some germ or germs, particle or particles, during that time. Yet we know that some individuals are exposed in this way; they officiate in sick rooms, and live in them, where hundreds of particles are present, without being prostrated by disease. If a soldier went into battle for seven days, and every day the battle raged from the beginning of the day to the end of it, and if he came out unscathed, then that case would be somewhat similar to the case of one abiding in a sick room a similar number of days, and coming out unscathed. I believe the reason of exception is to be found rather in the fact that there are many individuals who receive, not one, but many, particles that might originate disease in others, but who are, happily, unprepared and unfit to give due reception to these particles, and on whom, therefore they fall innocuously.

There are thus two facts ever to be kept in mind

in dealing with disease germs. We recognise their existence. We recognise that there are certain particles capable of originating certain diseases that may be communicated from one individual to another. And we equally recognise that there must be a fitness on the part of the individual that is exposed to contagion to be affected by these particles. Our sanitary reformers give attention rightly to the various methods that can be devised and put into operation for destroying these disease germs. They isolate the patient. They secure that the room in which he lies is thoroughly well ventilated. Pure air is one of the best disinfectants. Whether it acts by not supplying the germs with the material required for their development, or whether, as has been supposed, it dilutes them, and in that way makes them innocuous, certain it is that thorough ventilation prevents infection to a remarkable degree. Special appliances are also used to disinfect or to destroy those germs or particles. Chlorine gas, the fumes of sulphur, sulphurous acid—and by-the-bye we find the fumes of sulphur mentioned in Homer's Odyssey, very long ago, as employed for this purpose—pitch and tar, or the active principle in them, as we now have it in the form of carbolic acid; these various substances are employed to destroy these particles that otherwise might be capable of communicating disease. Professor Lister has used carbolic acid in preventing cer-

tain very serious complications that frequently annoyed and baffled the surgeon in the treatment of wounds. Poisonous germs, as in the case of hospital gangrene, often found their way into wounds and made them take on a very "angry" form—I am using a surgical term—and become irritable and intractable. Very deadly consequences have in this way often followed from apparently simple injuries. Professor Lister has obviated this fatality to a most marvellous extent by preventing these mischievous germs from affecting the exposed tissues. In carbolic acid dressings, which kill the germs, he has supplied a sure protective. By the destruction of these germs we can disinfect clothing and hangings of different kinds that may have been used in rooms where infected patients have been nursed. This may be accomplished not merely by the action of such substances as I have referred to, but also by subjecting the infected materials to a high temperature, which apparently has the power of destroying the vitality of these germs. All these facts seem to support the theory that these germs are living organisms, that are capable of propagating themselves, and that they can be killed and consequently made inoperative by influences that are inimical to their life Carbolic acid is decidedly destructive of certain forms of animal life. This can be shown by putting a small quantity into water in which these animalcules are present. And the other substances to which I

have alluded, and the high temperature of which I have spoken, act in the same way.

I should not, however, be dealing fairly with this subject if I did not add that Dr. Lionel Beale has propounded a theory for which a great deal can be said.[1] He maintains that in diseases of this zymotic character, we find a sufficient explanation of their character in the production of degraded or degenerate bioplasts. You remember that these bioplasts are used in building up the different parts of the body. They receive the food and change it into formed material. Dr. Beale's theory is that these *degraded* bioplasts multiply rapidly—at an extraordinary rate—and that at the same time they spend all their strength in this increase, and instead of building up the tissues, they simply build up and spread themselves, consequently the body wastes. These selfish bioplasts avail themselves of the material supplied simply for their own growth and multiplication. They are, so to speak, rudimentary bioplasts, bioplasts that do not exercise their proper final functions, and that are concerned wholly and only in their own growth and increase.

In regard, however, to all these cases of disease there is one remark of which I am sure you will at once see the significance when I make it. We should

[1] *Disease Germs; their Nature and Origin.* By Lionel S. Beale, M.B., F.R.S., &c.

strive to maintain our own bodies in the best condition for resisting disease. We may trust the sanitarians to suggest and supply means for dealing with these external causes. When they prescribe precautions in cases of sickness to prevent its communication, we ought to follow their advice fully and honestly, particularly, when they urge us to avoid all *unnecessary* communication with those who are suffering from such maladies we should observe a rigid quarantine.

I think it is the duty of those who can help the sick to go to them. Of course proper precautions should be taken, and there should be no unnecessary exposure; but if I can bring them help it is my duty to go, and I may confidently leave myself in God's hands. But to go *needlessly* is not only to endanger ourselves but, I may add, to injure the patient; for it is requisite in all cases that the patient should have plenty of fresh air and be kept perfectly quiet and in an equable condition. And if there are half a dozen persons in the room, as I have often seen in cases of scarlatina and measles, they consume a large amount of wholesome air, lessening the amount that the patient receives; and almost invariably they excite and injure the sufferer. They not only run risks themselves in breathing the vitiated atmosphere and exposing themselves to the incursion of these germs, they actually lessen the chances of the patient's recovery. We should not needlessly or without cause expose ourselves to any of

these risks. And we ought also to be careful to remove everything that may have given lodgment to these disease germs. You are quite prepared for this statement, that dirt is one of the best preservative receptacles of disease germs that we know. The sick room should be clean and sweet. The poison of scarlet fever may hang about a room for months, especially if it has hangings of any kind. Hangings of all sorts are abominations, and the more thoroughly we get quit of them the better. They give quiet lodgment to dirt without revealing it. If you will have hangings have them white, because then they become unsightly as soon as the dirt gathers on them, and you are obliged to have them removed and cleaned. But it is better still to banish them from all our rooms, and especially from sick rooms; and special care should be taken for their disinfection in cases where they have been used.

You can understand the reason why there are penalties attached to carrying persons suffering from infectious diseases in a cab or in any public carriage. Possibly no mischief may follow; but the risk should not be run. We ought in all such cases, even at the cost of much trouble and expense, scrupulously to avoid exposing others to dangers that we ourselves would not like to encounter. All these precautions, however troublesome they may seem, have for their end the well-being of the whole community, the banishment of all those seeds of disease as thoroughly as possible

from the city and from the nation; and we ought to support those who labour in this work. But speaking more practically still—and this is the special matter to which I again call your attention—we may all endeavour to maintain our own bodies in such a condition that they are least likely to give welcome to any of these disease germs. Friends sometimes consult me about their ailments. They wish me to give them some specific that will remove unpleasant feelings, or mitigate unpleasant symptoms. Almost invariably my advice is—it may seem vague, but it is the best I can give—Avoid everything that weakens your health; do everything that strengthens it. I confess that is some what vague and troublesome advice, because it is far easier to drink a bitter mixture and be done with it, than to be watching day and night against foul air, against over-tasking, or fatigue of any kind, and especially to be guarding against vices that ruin not only the soul but the body. Yet it is only by attending to this principle—avoiding everything that weakens or depresses, using fit food, and securing plenty of fresh air, fair exercise and cheerfulness, and all the other elements that go to build up the body in vigour—that we can preserve our bodies so that they may pass harmless even through a storm of disease germs. We can only preserve ourselves from perilous attacks by maintaining our vigour fully and constantly. And often in cases in which there are hereditary weaknesses,

"to be fore-warned is to be fore-armed." We can do a great deal to prevent the development of these weaknesses into positive disease, by guarding against the modes and circumstances of life that are known to excite them. I do not know a more fell disease in our own country than consumption; yet it is well known that there are many people who die of other diseases altogether, whose lungs are found on *post-mortem* examination to be full of tubercles. Consumption depends upon the formation of these tubercles in the lungs; wasting, with all the febrile symptoms, follows, when these tubercles begin to soften and break up. Yet there are people who live to an advanced age and die of other diseases, with their lungs containing growths of tubercles that somehow never have begun to break up. There are other cases in which these tubercles in the lungs are found to have changed into a chalky material, something quite different and quite harmless, so that there has been an alteration—a natural cure—which has protected them from an outbreak of this fell disease. These are suggestive facts. The truth is that, though we have weaknesses of any sort, if we know beforehand, and avoid the causes that develop and increase them, we may pass through life, having a weakly body, yet living a fair length of time and doing a fair amount of work. And one of the principal precautions, for instance, against the formation of these tubercles is to take

care that we have wholesome food, and that we properly digest it. The mischief begins probably in the use of improper food, or in imperfect digestion; consequently wise practitioners nowadays are careful to give certain elements—whether rightly or wrongly, I do not determine—to individuals in whom this tendency is supposed to lurk. They give them cod-liver oil, or cream—substances containing a large amount of fatty matter, and in some instances hypophosphites. It is supposed that by means of these the tendency to the formation of these deposits is arrested.

But for general purposes the advice I have given you will find most practical, and, with care, the most practicable as well. The more weakly we are, the more we need to take care that we do not indulge in anything that lowers the little strength we possess. It is quite possible to find out what upsets us, and makes us feel uncomfortable and less able to do our work than we would otherwise be. By avoiding these readily discoverable causes, we may maintain our bodies in a fair condition throughout a tolerably long life. I do not know any advice more fruitful if properly considered and rightly used than this simple one: Avoid carefully what you discover by experience to be hurtful, and yield a prompt and steady obedience to the natural laws that regulate the well-being of the body.

VIII.

RATIONAL PRINCIPLES OF MEDICINE.

IN the literature of different times and different countries shafts of sarcasm have been levelled at our good friends the physicians. Le Sage, in his portraiture of Sangrado, and Molière under the generic name Sganerelli, pilloried some of the practitioners of their time. And no one who is acquainted with the various changes that have taken place in the methods of medical treatment can wonder that, in one generation after another, objections have been urged, and urged very forcibly, against the different forms of practice existing in those times. Even in the last fifty years we have noted very remarkable alterations in the practice of physic within our own country. I can remember when almost all diseases of a certain class were treated by what were then called anti-phlogistic remedies; bleeding, blistering, lowering treatment of different kinds were had recourse to in order to subdue certain increased inflammatory action which, it was commonly supposed, could not be otherwise checked. More recently the theory gained ground

that all diseases were *caused* by weakness, and that the one mode of treatment for weakness was stimulation. And it is not so long ago that alcoholic mixtures of different kinds and qualities were prescribed very widely and very boldly in the treatment even of fevers and inflammations. Nowadays, orthodox medical treatment is not destructive, but constructive, and the endeavours of our wisest and most intelligent practitioners are directed to the building up of the body, to the supply of such elements as are natural and needful for the accomplishment of its various work and the fulfilment of its divers functions.

If we survey the *Materia Medica*—the various remedies that have been in use from an early time to the present—we are impressed by the strangeness of many of the articles, and by the variety of sources from which they have been taken. Charms and incantations, amulets and other things of that sort, were supposed at one time to be very effective in the treatment of disease, and I believe in some parts of our own country prejudices in favour of these remedies linger still among the uneducated.[1] It was supposed at one

[1] "A very common usage during the middle ages was to measure the sick person, at one time to cure him, at another to find out if the disease was decreasing or increasing. Another means was to drag him through a hole. Sick children were pulled through holes dug in the earth, or through a cleft cherry-tree. Another remedy against many kinds of suffering was the binding of a thread or a band which had been read over, around the neck or some limb of the sick."—Rydberg's *Magic of the Middle Ages*, p. 216.

time that a sufferer from ague, by leaning against a peach-tree, could transmit the disease to the tree, which forthwith died, while he himself at once regained health and soundness! Various expressions, rhymes of different kinds, were at one time in common use for banishing the pains and weaknesses that afflict humanity. All intelligent people have now got rid of these fancies, and of a great many other fancies equally foundationless; nevertheless, those absurdities exercised great influence over many, a century or two ago, whose intelligence in other respects was certainly not less than our own. You are aware that in our own country it was once very commonly believed, that the touch of the king's hand was a cure for scrofula; and there are many instances recorded of poor patients brought to the reigning monarch to receive the virtue treasured in the royal palm. There is an interesting account of this superstition in Macaulay's History of England,[1] and it was a question of very earnest discussion, even among those who were doubtful of the propriety of yielding to this superstition, whether it was wise, on the part of William, after the fall of the Stuarts, and in the circumstances of the Revolution, to refuse to exercise this healing power. It was argued by friendly politicians that if he did not yield to the common prejudices, it would be asserted by his opponents that this arose from the fact that he was not

[1] Macaulay's *History*, vol. v., chap. xiv., p. 105. Ed. 1858.

king by Divine right, and consequently did not possess the Divine gift—the power of banishing disease.

We find in the obsolete *Materia Medica* such articles as moss from a dead man's skull, the excrement of serpents, pulverised toads, and all kinds of abominations, lauded in their time as effective cures for certain ailments; and it is not a little wonderful that, under such strange methods of treatment and with those extraordinary remedies, people seemed to recover almost as readily as they do under the rational treatment which we apply to similar diseases in the present day. Indeed, it is one of the most startling facts that has not failed to arrest the attention of every student of medicine, that in all periods of history, and under the varying forms of medical treatment, the bills of mortality on ordinary occasions have varied very little, and that people have recovered from diseases under methods of medical management the most diverse and opposite, and recovered apparently as thoroughly as they recover now under what we consider most careful and most judicious treatment. And it seems to me stranger still that this fact has not led more than it has yet done to a consideration of this important truth, that in a large proportion of diseases there is a natural tendency to recovery. Whether we interfere or not, these diseases will run a definite course, and in due time the malady will disappear. We may treat them

by very severe measures, or by very gentle measures; we may treat them by very foolish measures, or by very wise measures: in the end the issue seems to be very much the same, and the patient gets well in due time, no matter how the doctor has fought the disease. I remember when I was a medical student that we were getting rid of the old-fashioned notions about heroic treatment in the form of bleeding and blistering. But in order to excuse our immediate forefathers, who had been very abundant in their labours with those remedies, the common theory advocated was that the type of disease had changed; that formerly diseases took on such a form as required active, depleting measures, but now diseases had taken on a milder form, or at all events a different form, and that they, the patients, could not bear such treatment, but were to be dealt with in a novel fashion. A student passing his examination during that period was asked the question: "How is it that patients recovered formerly under bleeding and blistering, while now they are cured by beef and brandy?" Of course the examiner expected to get the reply: "Because the type of disease has changed." But the student, whether from ignorance or excessive knowledge, gave this answer: "I suppose, sir, it is because our *patients are a great deal tougher than we thought.*"

Certain it is that patients have recovered and do recover still under very different kinds of treatment—

under very markedly opposite forms of treatment. There is scarcely an hospital that is devoted to a specific mode of dealing with diseases that is not able to produce its large percentage of recoveries—whether homœopathic or hydropathic; our temperance hospital, where alcohol is banished altogether, our old-fashioned hospitals, in which we have the ordinary remedies employed very much after the old fashion—they can all produce a large percentage of recoveries. And each one pleads that this percentage proves that its mode of treatment is best. Medical men are naturally somewhat doubtful of inferences drawn from these facts, and they have been accustomed to argue in many instances where the treatment is contrary to their judgment and belief: "Oh, your cases are mild cases, in which any treatment suffices, and in which any kind of medicine can do very little harm." By crediting the mildness of the disease with the cure, they hope to escape the other conclusion, that the peculiarities of the treatment were adequate to its removal. When homœopathy was introduced into this country, a very skilful physician was told that now men were being cured by infinitesimal doses of medicine. He said: "That is nothing wonderful to me, for I have been accustomed to cure a great many patients with no medicine at all!" And really there is a wonderful amount of suggestiveness and significance in this statement. There are men, not

the least wise in their profession, who are inclined to interfere as little as possible with the progress of a very large number of diseases, and who are not particularly anxious to introduce into the body any active drug of any kind whatever. They are adopting what I may call a wise expectancy. They are not disinclined to interfere if they see they can do it to good purpose, but unless there is something clamant that demands their interposition, they are rather disposed patiently to wait until the disease runs its course, and convalescence sets in according to their anticipations.

We know very well that recovery in many cases does not take place, but in a much larger proportion of cases of disease recovery does take place. I suppose most of us have suffered from some diseases at some time or other, but we have not died yet. That is to say, we have passed through these diseases and recovered. The time will come when we shall pass into disease and not pass out of it except by the gate of death. Still, there are a great many diseases through which we as individuals pass that do not cut short our life; diseases which issue in recovery. And when we compare the recoveries from disease with the number of deaths from disease, we find that the recoveries largely preponderate. In all these cases of recovery if there have been active treatment employed—I do not care of what nature it may have been, blister

ing, bleeding, alcohol, quinine, acids, alkalies, or what not—in these cases of recovery the particular treatment is credited with the cure. The cure may have been determined by the simple fact that the disease was not strong enough to overcome the patient, or that the patient was strong enough to overcome the disease. It may have thus resulted as a natural necessary process; nevertheless the treatment gains the credit, and the physician gains the honour. Herbert said in one of his proverbs long ago: "God cures the patient, but the doctor gets the thanks." The treatment employed is credited with the removal of the disease, whereas all the time that treatment may have really been opposed to recovery; it may have delayed recovery; it may have made the evil worse than it would otherwise have been. When, however, the bystanders see that a particularly active treatment is followed by recovery, the active treatment is believed to have been the cause of the recovery. You will find a great many cases in the newspapers in which there are certificates given—I believe in good faith—by individuals who have profited largely by this man's ointment, or that other man's pills. "I had such and such a disease. The doctors gave me up. I got a box of your pills (or a pot of your ointment), and in the course of two or three weeks I became a new man. Gratitude demands that I should give you thanks for my recovery, and put on record the won-

derful potency of your medicine for the encouragement and example of others." Now I believe these testimonies are often given in good faith. There may be simulated cases, but I do not lay any stress on this possibility. I believe in a great many instances there may have been recovery in connection with the use of these pills, potions, or ointments. But the question is: Did the recovery spring from the use of these pills, potions, or ointments, or was it brought about *notwithstanding them*, in some other way? It is a very difficult thing to ascertain how far interference with the natural process, in any case, is beneficial, or how far, on the other side, it is hurtful. Besides, we have only testimonials to the cures; how many more testimonials could be found for the failures?

At one time a visitor at one of the temples of the gods found there a great many votive tablets on the walls. This man had been saved from shipwreck by calling on the gods; another man had been saved from deadly peril by calling on the gods; another man had been saved in the very instant of death from mortal disease by calling on the gods. These tablets were all put there to record gratitude and to give the honour that was due. This gentleman who visited the temple was rather of a sceptical frame of mind, and put this question: "Where are the tablets of those who called on the gods and yet perished?" A great many were in the habit of calling on the gods, and out of

that immense number a sufficient proportion to cover the wall with tablets really survived. But were they saved by the interposition of the gods, or by some other cause altogether? It is so precisely in regard to the operation of drugs. It is very difficult to tell, almost impossible to tell, whether or not the drug on which the most reliance is placed has proved its value. Recovery has taken place, but whether it has been due to the action of the drug, or to another action altogether different and opposite to that, it is almost impossible to say. The truth is, I believe, that in looking to *specific* remedies either for cure or prevention of disease, except in very few instances indeed, we are departing from the right method.

Speaking generally and broadly, I have little faith in the action of poisons for the restoration of the body to health. There are cases, I am quite willing to admit, in which specific remedies appear to produce almost invariabl and desirable results. For instance, in certain conditions iron is undoubtedly a restorative (if in these cases it may not be more correctly classed as a food), and quinine is undoubtedly a protective against malarial poison and a remedy in intermittent fever. It may safely be affirmed that we have evidence of these functions of iron and quinine from long-continued use and proof. But in the thousand-and-one dissimilar cases of medication we are not able to speak with anything approaching to the same posi-

tiveness. Alchemists were diligent in search, not only for the stone that could turn all metals into gold, but also for the draught of immortality that could secure them against the insidious assaults of death. They sought with restless eagerness the *elixir vitæ*, as it was called, which they fondly hoped would lengthen out their life by centuries. Thanks to the alchemists and their labours, we have reached that wonderful science chemistry, but we are as far from the discovery of this potable health and from the possession of the gold-producing stone, as they were in their earliest days and dreams. As we have grown wiser, we have given up the search both for the one and the other; I am not quite so certain that we have abandoned the quest for panaceas. In the continual experiments being made with new drugs, and in the untiring attempts to find some specific for each variety of diseased action, there seems something like a survival of the old superstition. I am disposed to think that currents of thought, setting strongly, if not even exclusively, in that direction, indicate a departure from the principles of rational medicine.

On the other hand, it is noteworthy that our most experienced and skilful physicians are recalling attention more to the means that are likely to prove useful in securing and maintaining the health of the community; and when they have cases of illness to treat, they are increasingly more concerned about removing obstruc-

tions that might prevent the process of recovery, than in applying some magical substance that will suddenly banish disease, and refill the body with healthy vigour. While fully recognising the necessity of removing whatever might obstruct or retard recovery, and keenly anxious to give full and fair play to what I may venture to call the healing processes of nature, they are becoming more reluctant to interfere directly with the animal functions by prescription of non-natural drugs.

I am not going to talk about the different methods of medical practice existing at the present time. I am not going to say a single word either in favour of or in opposition to allopathy, homœopathy, hydropathy, Kinesipathy, or any of the other "pathies" with which we are familiar in these days. No doubt they all have their advantages and their disadvantages. I believe that the principles of rational medicine are to a large extent compatible with the theories of any of these schools; although a rational physician would not restrict himself to any one narrow mode of treatment. A wise eclecticism will not reject the lessons of experience wherever found and however exemplified.

Our allopathic friends are certainly a great deal less disposed at the present time to active treatment than they were some thirty or forty years ago. Whether this is to be credited to other schools or not, the fact at least abides; and care is given, as I have indicated, to the maintaining of the body in the circumstances

best adapted to allow it freely to exercise its own natural powers. It has been found that the human organism is not merely able to carry on its own functions in heaith, but also that it is able to recover itself, when recovery is possible, from disease. As I have already said, there are cases in which recovery is not possible, whatever be the reason. There are cases in which recovery is beyond the range either of nature or of art. And in these cases no kind of treatment, no drugs that we can take, will avert the issue that we dread and deprecate. There are diseases that, in the circumstances in which the patient is placed, are necessarily fatal, and we cannot prevent that necessary termination. It is well for us to keep this in mind. Because oftentimes the physician is blamed wholly without cause. Sometimes, as I have said already, the physician gets praise to which he is not entitled. If the patient recovers, he is thought to have had the principal share in securing the recovery. If the patient dies, he is often accused of not having done enough, or of having been unskilful in his treatment, and of thus being to some extent responsible for the death of the sufferer. Now, it is not fair, at least invariably, to lay the blame upon the physician. In a certain number of instances, no matter what kind of treatment is adopted, no matter what skill we may be able to command, the possibility of averting a fatal termination is beyond the power of man. There are cases in which recovery is

almost certain; there are cases, I believe, in which it is absolutely impossible. And we are not always able to determine beforehand with anything like accuracy which are cases of the one sort and which are cases of the other. But I would have you note that in cases in which recovery is possible the recovery commonly ensues, whether the patient is treated wisely or foolishly. I do not mean to say that wise and foolish treatment are of equal value. I hold very distinctly that foolish treatment is injurious. It may prolong the disease, and it may also make convalesence more tedious and less thorough and effective than it might otherwise have been. On the other hand, wise treatment removes obstructions to the action of nature, allays distress and pain, expedites restoration to health, and may also shorten the period of convalesence and perfect the recovery. There is a real difference between wise and foolish treatment; but in cases in which recovery is the natural issue of the disease, it must be very foolish treatment indeed that will prevent this issue. And in cases in which death, from the state of the patient or from the character of the disease, is the necessary termination, no wisdom of any kind whatever can avail in averting that issue.

It has been said that a physician is like a blindfolded man with a club in his hand. He strikes at two beings—the patient and the disease. If he makes a happy hit, he kills the disease; if he makes an un-

happy hit, he kills the patient. And in many cases it is urged that his treatment is a game of "double or quits," and that by various expedients, of which he cannot determine the wisdom or folly, he essays to reach a definite end. I am not at all prepared to agree with these representations, which I think are really caricatures and misrepresentations. At the same time some of our wise men have very earnestly questioned whether or not on the whole there would have been less mortality if there had been no medical art and no medical practitioners than there has been with the medical art and with medical practitioners.[1] Physicians themselves have gravely argued this question: whether, on the whole, the art of physic has been a blessing to the human race, or something very much the reverse. And you can understand the reason why they raise this question. If all physicians were wise, and had what Chomel[2] calls the first requisite of the physician—good sense—there would be no need to raise the question. As people in a great many different professions, although having the other gifts and graces pertaining to these, are yet destitute of this one thing—good sense—so in the profession of medicine there are many educated physicians as the world goes, and many scientific physicians, who yet have not this quality.

[1] Sir John Forbes' *Nature and Art in the Cure of Disease.*

[2] In his treatise on General Pathology. Quoted in *Flint's Conservative Medicine*, p. 141.

And there are many others who practise their profession as a matter of routine. In these circumstances there may be only a small number of the "good-sense" practitioners and a large number of the careless and unskilful. For want of this good sense there may be more mischief done than there is good done on the other side. That is no argument against good treatment or wise treatment; it is an argument against foolish treatment. It is a reason why we should hesitate to admit the ability of physicians in all circumstances to treat wisely and carefully the diseases with which they have to deal. But it is no reason why we should doubt one who is intelligent, who has this good sense, who does not interfere when he does not see that interference is actually called for, and who is prompt in removing difficulties out of the way, and arranging surrounding circumstances in favour of the patient—no reason why we should not trust him wholly and heartily in his treament of any particular case.

A great many foolish things have been said against physicians. And I am not prepared to defend those who are in the habit of using active drugs rashly and continually. I believe there is such a thing as meddlesomeness in medical practice, and that there is a tendency on the part of patients to accept and admire meddlesomeness. There is a disinclination to be simply cared for. We have an idea that we ought to

have some drug—the more nauseous, the more likely to prove useful—administered to us. I believe that in five cases out of six the best treatment is care, nursing, watchfulness, avoidance of such diet as might aggravate the malady, full nutrition, so far as it can be secured, arrangements for procuring rest and sleep, and such disposition of air, light, &c., as are likely to prove serviceable in the restoration of health. And yet in how many cases would the patient be disappointed if this were all that a skilled physician called to his bedside ventured to do. Yet I repeat it would be better in five cases out of six to depend almost wholly on such treatment as this. I have a real prejudice, and I think not an unreasonable one, against drug treatment when it can possibly be avoided. I am not laying down the principle, because I am not prepared to do so in the present state of our knowledge, that in all cases we are to abjure, and abstain from, drug treatment. There are instances in which we are obliged to have recourse to these remedies, because we do not know what else to do; and on the whole it is supposed that by means of them certain alterations in the condition of the body can be brought about that may prove favourable to the progress of the cure. But I am quite convinced—and I venture to think that many physicians who have carefully considered the whole question are drawing nearer and nearer to this conclusion—that a better future in medical science will be reached in proportion as the

study of natural healing processes enables us to dispense more and more completely with the employment of drugs in the treatment of disease.

It has been argued by allopathists that the success of homœopathists is determined by the fact that they do not give their patients medicines that have the slightest possible effect upon their condition. Adopting that argument, without inclining to one side or the other, it is a very serious matter that such an argument should be urged. If without any treatment patients do recover in large numbers, it must lead us to look with grave suspicion on treatment of another kind in which active drugs are freely employed. The truth is, it would be of immense advantage if we could get a true natural history of the various diseases. If it were possible for us so to isolate distinct cases of illness that they should be under no treatment whatever, except such as a wise physician would adopt in regimen and diet, in the arrangement of condition and surroundings, in the administration of such elements as are needful for the normal well-being of the body; if we could have a number of cases treated in this way, apart from infinitesimal doses as well as large doses, without any active treatment, as it is commonly called, of any kind, I am convinced that the results could be, if not astounding, at least suggestive and valuable. It is very difficult, however, to get such cases, for people are inclined to think that there are drugs in the Phar-

macopœia that can cure every ailment under the sun, if only we were sagacious enough to lay our hand upon the proper drug in each particular case. They are disappointed and grieved when allowed to suffer without the application of any of these medicaments. Indeed, there seems to exist a notion among the vulgar that diseases are like rats in a house—you require to poison them to get rid of them; and they are confident that there are certain drugs that have this power of poisoning certain diseases.

A great number of theories have been devised by the learned to account for the presence of disease, and to explain satisfactorily to their own minds the methods of treatment that should be adopted. In the early days, the followers of Hippocrates supposed that diseases resulted from the redundance of certain materials in the system—an excess of phlegm in winter, and of blood in spring, of yellow bile in summer, and of black bile in autumn. In all these cases they endeavoured by the elimination of the phlegm, or the blood, or the bile to recover the patient. Later still the theory found currency that disease was morbid force, and that we could correct it by exciting in the body an opposite force strong enough to resist the other. Galen and others who followed him adopted this method of exciting an opposite action in the body to that which they found operating injuriously. Then in later times we have had physical theories about the

relations of the solids and fluids, and chemical theories about the actions of acids and alkalies, &c.

We have had all kinds of theories of disease, and corresponding theories of treatment. "We are satisfied that we do not err in saying that the most judicious practitioners of the present day accept the following maxims of that eminently conservative physician Chomel: *first*, that we are not so much to treat diseases as patients affected with disease; and *second*, that not to do harm is no less an object of treatment than to do good."[1] One rule of very large significance, though scarcely adapted for discussion within our limits, is to obviate any tendency to death that may appear. Of course this can be done in some cases. There is what we call inflammation of the windpipe with œdema of the glottis, which may almost in an instant cause suffocation by preventing the entrance of the air through the narrow chink into the lungs. When death is threatened by the closure of this narrow opening, we open the windpipe lower down, and put in a tube, so that the air may get freely in, and wait patiently until nature, if it has the power, removes the disease. This is a case in which inference may certainly be employed to good purpose. If we are able to foresee, as a skilful physician often may, a tendency to sinking which we can counteract, or which we may meet by careful attention and by action, then we may so treat

[1] Flint's *Conservative Medicine*, p. 21.

the patient as to tide him over the difficulty. We must not forget, however, that a physician is not the master of nature, but the servant,[1] and his particular work is mainly to assist and not to command the natural processes whereby danger is averted. If we knew exactly and fully the natural history of disease, it is evident that we should possess ample information to guide us in many such cases. The study of nature here, just as in other directions, really lies at the basis of practical knowledge, and until we gain this knowledge in fuller measure than we have yet done, we shall not be able successfully to treat disease to the extent that we could wish. The physician himself cannot heal, but if he knows the process of nature in healing, and can facilitate that process, or remove anything that would obstruct it, he may, in this way, become the handmaid of nature in securing a desirable termination.

You will find in the handbooks that deal with the treatment of disease this always laid down as a direction—that we must endeavour to sustain the strength of the patient and attend to his general health. Lowering or enfeebling measures, even exciting or stimulating measures, we may regard as doubtful, if not dangerous. You may stimulate a patient so that he puts forth a great deal of energy; but if he wastes the energy and you do not supply him with new energy,

[1] "Medicus naturæ minister non magister est."

you will do him no benefit. It is no advantage that the energy be spent. It will be all needed, probably, before recovery is secured. We require to husband it, and, if possible, to guide its use in right and safe directions. And what we ought to be most careful to do, is, by nutrition to maintain the energy of the patient, so that he may have a sufficiently large stock of it to be available in any direction—for the resisting of mischief or the recovery of health.

An explanation of this subject in all its details would take a great deal longer time than we can afford; but I do not know any better way of expressing myself than in the very simple language which I used in my last lecture. Our leading aim must be to attend to the general health of the patient, and to the maintenance of his vital power. The lessening of that vital power is dangerous. Let us do anything that is possible to lessen the power of the disease; but let us be chary of lessening the power of the patient. For even if it were possible to lessen the power of the disease by lessening the power of the patient, that lessening of the disease may be mischievous because of the equal lessening of the vital power. It *may* sometimes be desirable to act in that way, though I speak here with hesitation; but there can be no doubt whatever that it is our duty in all cases, in the treatment of ourselves as well as in dealing with others, to pay our main attention to the sustaining of the powers of life right on to the end.

And I believe that it is in this direction the art and science of medicine is likely to make rapid advance in the future. As a class, physicians have always taken the highest rank in earnest, self-denying labour for humanity. Even when mistaken, they have been honestly seeking to help and heal. At present there seems to be a tendency among them to a more cautious and, if I may be allowed the expression, *tentative* use of drugs—and drugs must be classed among the *available*, if not the most *desirable*, remedies—while there are hopeful indications that at no distant date, by the perfecting of sanitary methods and by the development of a natural treatment of disease, the "opprobria medicorum" will cease, and an intelligently-grateful community will heartily unite in the prayer, "Res medica floreat."

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